The Thesis Committee for Olfa Hamdi
Certifies that this is the approved version of the following thesis:

Advanced Work Packaging from Project Definition through Site Execution: Driving Successful Implementation of WorkFace Planning

APPROVED BY
SUPERVISING COMMITTEE:

Supervisor: _____
Fernanda Leite

Co-supervisor: _____
William J. O'Brien

Advanced Work Packaging from Project Definition through Site Execution: Driving Successful Implementation of WorkFace Planning

by

Olfa Hamdi

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Dedication

Dedicated to my parents.

Acknowledgements

As a Tunisian woman, I am proud to be here today and grateful to those who have helped me reach this point. Hodding Carter says: "there are two lasting bequests we can give our children: one is roots, the other is wings" – I cannot better describe the role my parents had in supporting my way to this; I can never thank you enough for your constant encouragement and support of my education.

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Abstract

Advanced Work Packaging from Project Definition through Site Execution: Driving Successful Implementation of WorkFace Planning

Olfa Hamdi, M.S.E

The University of Texas at Austin, 2013

Supervisors: Fernanda Leite and William J. O'Brien

Capital projects use work packaging to divide their projects' scope into manageable portions of work for planning and execution, all to achieve improved productivity and increased predictability. However, currently, no common industry standard for work packaging is widely and uniformly implemented within the North American capital projects industry. As documented by CII RT 272 Phase I (2009-2011), companies have been implementing a number of varied work packaging practices at different stages of the project lifecycle with emphasis on the construction phase. Due to the varied implementation, there is currently little evidence of the benefits of extending work packaging to the Front End Engineering Design (FEED) and the Detailed Engineering (DE) phases. To provide the best current evidence, this thesis describes new findings on Advanced Work Packaging (AWP) as an execution practice, with special emphasis on design activities. This research combines data collection methods such as interviews, observations and document review, as well as surveys. The reader will understand the current industry status on Advanced Work Packaging in terms of levels of implementation as well as evidence of benefits and implementation challenges across the project lifecycle. Documented benefits include productivity improvements on the order of 25% in the field, with

corresponding reductions of 10% of total installed cost. Other significant benefits include improved safety, improved productivity, less rework, significant reduction in RFIs and increased stakeholder alignment. Documented AWP implementation challenges include lack of process formulization, persons' resistance to change and lack of buy-in, stakeholders' conflict of interest and working culture, incompatibility with some contractual scenarios as well as traditional change management practices.

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CHAPTER 1. INTRODUCTION

1.1. RESEARCH BACKGROUND

WorkFace Planning (WFP) is "about getting the right things to the right people at the right time to save money and improve productivity in large-scale construction projects." (Construction Owners Association of Alberta, 2005). The Construction Owners Association of Alberta (COAA) recognized it as a best practice in 2005. The purpose of the development of WorkFace Planning (WFP) was to overcome the challenges that the Alberta region is facing in executing and construction its Oil Sands projects. Those challenges are manifesting in cost overruns including in front end planning, design, procurement, organization processes, construction, etc.

In 2009, the Construction Industry Institute (CII), an American non-profit consortium of more than 100 leading owner, engineering, contractor and supplier firms, initiated a Research Team (RT) aiming to develop an executable model of enhanced work packaging based not only on WorkFace Planning but also on other industry work packaging practices. Following a review of industry and trade literature and in conjunction with the development of case studies, the team developed a lifecycle execution model for work packaging with an emphasis on field implementation (Meeks, 2011). The team reported out on its Phase 1 findings at the CII Annual Conference in Baltimore in July 2011 and also held an implementation session during the same conference.

In 2011, a research joint venture between The Construction Industry Institute and The Construction Owners Association of Alberta was initiated within the scope of the research team RT 272 to work on more advanced vision and practices of work packaging; hence, the new appellation: ADVANCED WORK PACKAGING (AWP). In fact, members from the Canadian think tank joined the team and further objectives were re-chartered to advance the subject and build on prior work. As stated in its research summary (RS 272-1), the research joint venture extended, through its second phase "the execution model with implementation guidance in terms

of integration flowcharts detailing integration of Advanced Work Packaging with current practices, contractual recommendations in terms of requirements and strategies, functional descriptions for roles and responsibilities, assessment and audit tools, templates to support key documents, and a small example of how Advanced Work Packaging integrates with traditional project controls."

As summarized in Figure 1, the research team (RT) 272 has known two phases:

- From 2009 to 2011 (phase 1): focusing on the development of an execution model for the project life cycle with an emphasis on field implementation along with a set of industry case studies and collection of benefits evidence.
- From 2011 to 2013 (phase 2 – joint venture between CII and COAA): extending the execution model of Advanced Work Packaging with consideration of implementation challenges documented through surveys and expert interviews in North America and globally.

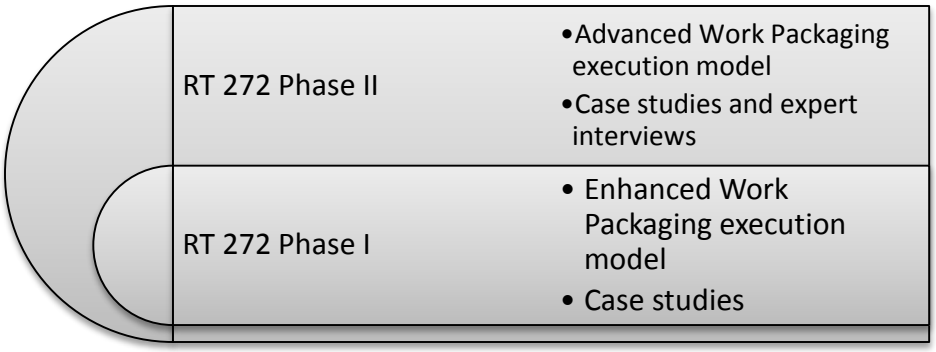


Figure 1 Research team RT 272 phases

As far as the relationship between WorkFace Planning and Advanced Work Packaging is concerned, we can state at this stage that WFP is a sub-process of AWP (see Figure 2). CHAPTER 4 details this relationship and presents a deeper explanation of the core processes for Advanced Work Packaging.

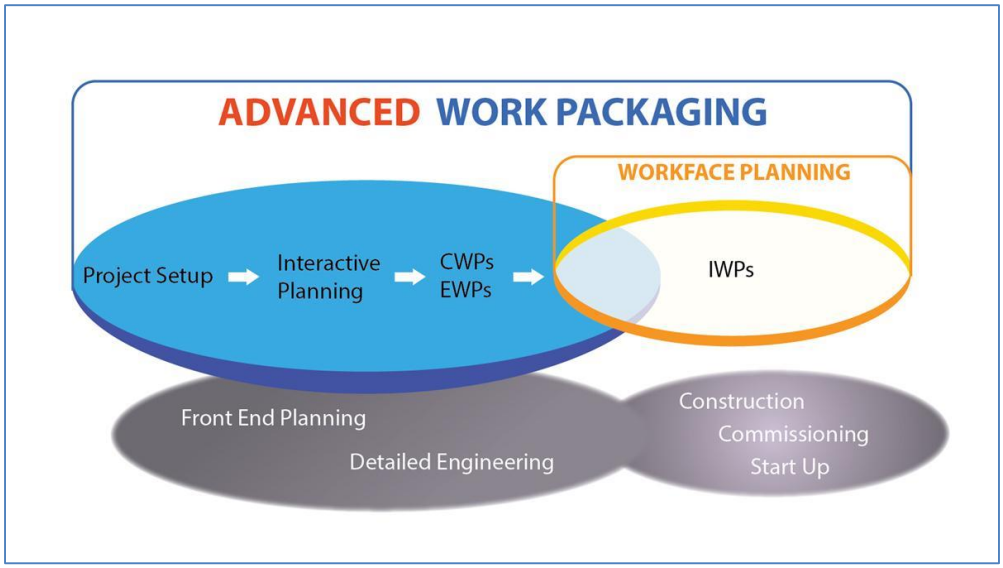


Figure 2 Relationship between WFP and AWP

RT 272 has also delivered four main documents including this one. Those documents are the compilation of four years of extensive research and intermediate deliverables on Advanced Work Packaging:

- Research Summary (RS 272-1): written by both academics and industry team members to provide a high-level overview of the research findings
- Three volume Implementation Resource: written by both academic and industry team members and documents the work packaging model findings, including the definitions, execution model, and tools
    - Implementation Resource 272-2, Volume I, Advanced Work Packaging: Design through WorkFace Execution,
    - IR 272-2, Volume II, *Advanced Work Packaging: Implementation Guidance*, and
    - IR 272-2, Volume III, *Advanced Work Packaging: Implementation Case Studies and Expert Interviews*
- Two Research Reports (RR 272-11 and RR 272-22): written primarily by the academics that conducted the interviews and documented the case studies and expert interviews.

1.2. PURPOSES, OBJECTIVES AND SCOPE

CII and COAA membership have a shared interest in WorkFace Planning. As both have invested in documenting and improving WorkFace Planning processes, the purpose of this joint project is to collaboratively extend their prior work to develop common work packaging implementation guidance for owners and contractors.

Key objectives are to develop implementation guidance around four high value topic areas identified by the team through its members' experiences but more importantly through a documented feedback from the industry experts and companies. Those four main areas are as agreed on and worded by team members during their kick-off meeting:

1. Elaboration of process to support implementation – in particular with respect to (a) details around organizational responsibilities and capabilities, and (b) information requirements to support WorkFace planning. Details will be built from phase one deliverables on process descriptions and COAA swim lane charts. Alignment of definitions among COAA and CII documentation is part of this topic.
2. Contractual requirements and contracting strategies to suggest what issues contracts should include and how WorkFace planning should be included in various forms of executions strategies that separate responsibilities between different engineering, procurement, and construction contractors.
3. Maturity assessment to aid general appraisals of implementation quality and help firms and projects identify where to focus implementation efforts.
4. Continued documentation of the evidence supporting WorkFace planning as well as documentation of implementation barriers and metrics used to support implementation. Empirical data collection will also support topics 1-3, above.

1.3. RESEARCH REPORT STRUCTURE

This document is the Research Report RR 272-22. It is mainly structured around phase II of RT 272 and in consequence, completes the Research Report RR 272-11 which reported into detail the team work during phase I.

This research report purpose is to 1) academically document the team dynamic and report on its methodology and deliverables 2) provide more detailed information about key concepts and findings such as the implementation barriers experienced by the industry.

It is composed of seven chapters. This first chapter introduces the context of this research work and the purpose and scope of the work performed. The second chapter covers literature review of the main key areas of study involved with work packaging, which leads to the identification of the literature gap and research questions covered by the team. The third chapter presents the team methodology and its work structure. This work structure is the basis for the chapters four, five and six. Indeed, the team was "virtually" divided into three sub-teams: the process sub-team, the contracts sub-team and the functional capabilities sub-team. For each one of the three findings chapters, we present the research team findings in conjunction with literature review as well as findings from case studies and expert interviews conducted through the two phases.

Chapter seven focuses on a theme of current interest to the industry: the Engineering Work Packaging in its relationship with other project phases and groups. This chapter aims to first present the team findings on the engineering side role in work packaging and second, lay the ground to future research on a broader scope for the interaction between the engineering side and construction side in our industry.

Chapter eight and final chapter conclusions, present a summarized compilation of the team and interviewed experts' recommendations with respect to the three thrust areas: processes, contracts, and functional capabilities.

CHAPTER 2. LITERATURE REVIEW & RESEARCH QUESTIONS

2.1. WORK PACKAGING FOR CONSTRUCTION

2.1.1. WORK PACKAGING DEFINED: FROM A PROJECT CONTROL MECHANISM TO A PROJECT PLANNING MECHANISM

The concept of breaking down projects into manageable work packages is one of the fundamental concepts of the Project Management body of knowledge and the execution theory. Early major work packaging research focused on project control, examining the coding relationship of work packages to time, cost, and people as represented by the work breakdown structure (WBS), organizational breakdown structure (OBS), and cost breakdown structure (CBS). The Project Management Institute (PMI) recommends using work breakdown structures (WBS) to subdivide a project into smaller manageable pieces (PMBOK 2004). "[A Work Package is] a deliverable at the lowest level of the work breakdown structure. A work package may be divided into activities. Also can be an accountable item of work." (PMI 1996).

In 1987 the Construction Industry Institute (CII) developed a report "Work packaging for project control" in which they also recommend breaking down projects into manageable work packages and give guidelines for using work packaging for project control. However, this "research has been devoted to examining the conceptual applicability of the work packaging concept and applying it as a general managerial tool. Only limited attention has been paid to the actual work packaging process" (Kim et al., 1995). More recent research efforts, including the Lean Construction approach as well as WorkFace Planning practices by the Construction Owners of Albert (COAA), were directed to determining effective work packaging methods and best practices.

Last Planner System, Lean Construction approach:

Lean Construction Institute (LCI) explains that with the Lean approach focuses on "improving total project performance instead of simply reducing cost or increasing the speed of a single activity" (LCI, 2009). Relying on three levels of hierarchical scheduling tools constituting the Last Planner System (LPS), the master schedule, the lookahead schedule, and the

commitment plan, the Lean planning system focuses on identifying the work to be done at fine levels of detail and reducing each activity's associated uncertainties (Pappas, 2000).

The LPS comprises four levels of planning processes with different chronological phases/deliverables (figure 1):

- Master Scheduling: results in the deliverable of the front-end planning that identifies major milestones and incorporates Critical Path Method (CPM) logic to determine overall project duration (Tommelein and Ballard, 1997)
- Phase Scheduling: results in a phase schedule that identifies handoffs between the various specialty organizations to find the best way to meet milestones stated in the master schedule (Ballard and Howell, 2004)
- Lookahead Planning: At this stage, activities are broken down in operations, constraints are identified, responsibilities are assigned and assignments are ready (Hamzeh et al., 2008)
- Commitment Planning: this is the most detailed plan in the scheduling process. It is very close to the construction process and is directly linked to continuous improvement tools.

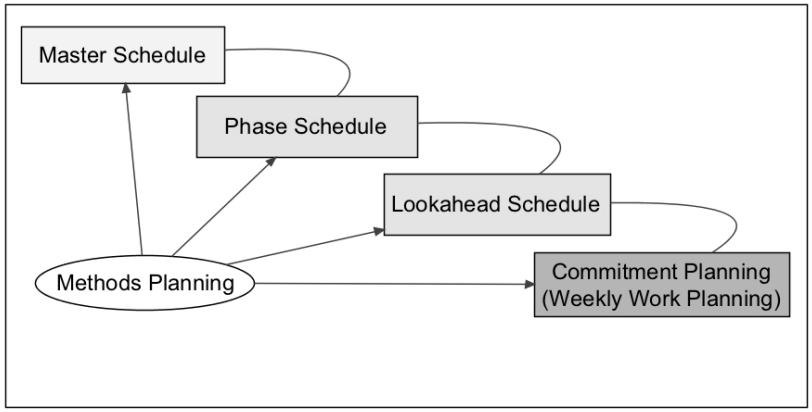


Figure 3 Planning Levels in the Last Planner System (Adapted from Ballard and Howell, 1998)

The corresponding output from the Commitment Planning scheduling level is the Weekly Work Plan. The commitment plan is an assignment-level schedule covering one week duration.

This schedule contains all of the work activities that are required to start that week in order to meet the lookahead schedule completion dates. Work assignments are pulled from the lookahead schedule onto the weekly work plan.

Lean Implementation Challenges:

The implementation process of any management system usually faces various obstacles related to organizational changes and to the nature of construction work and its requirements. For lean construction implementation process as for any other system implementation, there are obstacles and challenges that were reported by researchers based on case studies (Liker, 2004; Ballard et al., 2007; Hamzeh, 2009). Ballard et al. (2007) studied the implementation of LPS on many construction projects and reported various implementation obstacles. Resistance to change within team members was the main obstacle to LPS implementation. In various cases, the lack of leadership during the process, in addition to the lack of commitment by managers were considered as implementation challenges. Hamzeh (2009) classified lean related implementation challenges into two sets of factors: local factors that are potential challenges attributed to project circumstances (new experience with lean methods, traditional project management methods, novelty of LPS to team members, fragmented leadership and team chemistry) and general factors that include human capital, organizational inertia, resistance to change, technological barriers and climate. Identified barriers from case studies in the literature are lengthy client approval process, the amount of paperwork routinely involved between employees, cultural issues, degree of commitment, attitude towards time, communication effectiveness between stakeholders and information accuracy and its relationship to the LPS process. Hence, some of the requirements for the LPS implementation success are: top management support, commitment to promises, involvement of all stakeholders and effective communication and coordination between parties. These requirements are defined by AlShemaimi et al. (2009) as Critical Success Factors (CSFs).

WorkFace Planning and Enhanced Work Packaging:

WorkFace Planning (WFP) is the process of organizing and delivering all the elements necessary for a work package, before the work is started. The basic concept of WorkFace Planning is the reduction of construction schedules by improving the coordination of information, tools and materials at the work face, where the work is performed (Ryan, 2009). As historically, planners are distant from the WorkFace and lack this proactive process which enables craft workers to perform their work safely, effectively, and efficiently. This is accomplished by breaking construction work down (by trade) into discrete work packages that completely describe/cover the scope of work for a given project. This process promotes the efficient use of available resources and permits the tracking of progress. WorkFace Planning process was considered as a best practice amongst constructors by the Construction Owners Association of Alberta (COAA) in 2005 (Ryan, 2009). This best practice was enhanced by the research team CII RT 272 (2009-2011) from the Construction Industry Institute that reviewed current work packaging practices and identified an enhanced model for implementation that represents best practice currently performed. This model contains an enhanced set of practices performed in industry for executing work face planning from project definition through turnover, with narratives provided for each of the three project phases specified and the distinct steps therein. While the model covers the entire project lifecycle (figure 2), emphasis is placed on field implementation. The model is supported by both a definition set and implementation and assessment tools.

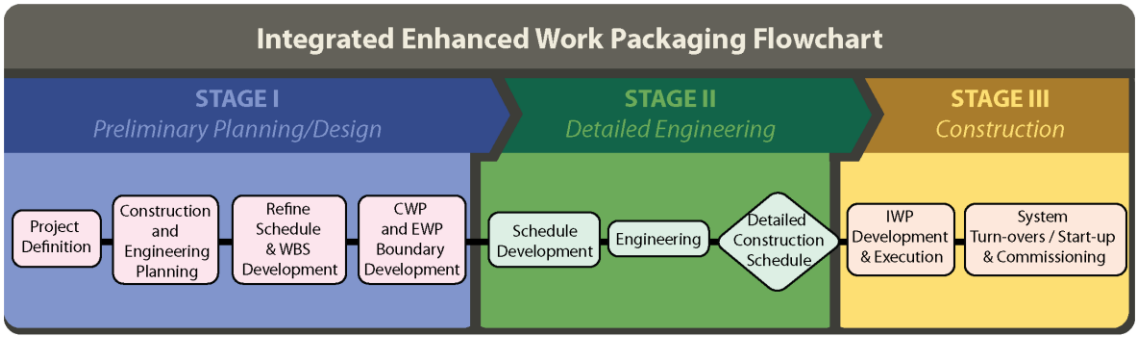


Figure 4 Integrated Enhanced Work Packaging Flowchart (CII IR 272-2 Vol1, 2012)

WorkFace Planning: evidence of implementation benefits and challenges:

The Construction Industry Institute has issued a case studies report in 2012 containing seven case studies and three expert interviews collected by the CII Research Team 272 Enhanced Work Packaging: Design through Work Face Execution (CII IR 272-2 volume II, 2012). The projects and companies selected for review within this case studies report were within a range of industrial and commercial construction sectors, including power, oil and gas, government, and commercial projects. The level of maturity for work packaging use varied from one case study to the other. More importantly, the report included evidence of success of work packaging use as well as a set of challenges that accompanied the process. High level benefits include: improved project party alignment & collaboration, site paperwork reduced, reduced rework, improved project cost & schedule, improved safety awareness & performance, more time for supervising, decreased supervisor & craft turnover, improved labor productivity, increased reporting accuracy, enhanced turnover and improved client satisfaction (Meeks et al., 2012). Reported challenges include: unmanageable sizes of packages, late implementation through the lifecycle, lack of support (CII IR 272-2 volume II, 2012). One of the widely recognized challenges was the gap between the Front End phase and the Construction phase in terms of work packaging. In fact, the COAA WorkFace Planning Committee Chair declared in one of the organization's conferences held in May 2012 in Edmonton: "We realized that problems were still occurring in the transfer of complete Front End Deliverables, on time and in the right sequence to Contractors". This point leads us to extend the literature review to the Front End phase which involves the engineering side and other stakeholders.

2.1.2. OBSERVATIONS

Terminology and scope:

As previously explained, the concept of work packaging had extended from being a project controls concept to being a project execution methodology. It is then important to understand that work packaging is not a new concept. In different ways, construction projects

have always divided the work to be performed into smaller portions and planned around these divisions to reach project goals. However, the terminology used within the Construction Industry differed from one sector to the other, from one geographical area to the other and even from one company to the other. In a lot of cases, the work packaging process was not explicitly labeled "work packaging". Within the scope of this research, we consider "work packaging" as the terminology that covers generically any method of organizing any work execution process within the scope of a construction project; for instance, any scheduling efforts taking into account procurement, site, and engineering constraints. This goes beyond the construction type of work and covers also the engineering and procurement work. Such a definition was also adopted by Smith (2008): “packages of work, usually referred to as 'activities' or 'tasks', are determined by consideration of the type of work, the location of the work or by any restraints on the continuity of the activity".

Emphasis on the construction side:

Intuitively, work packaging is automatically correlated with the construction side of projects. This involves the construction phase and the construction people. However, one might also question work packaging as a process within the engineering side as well as within different stages of the project lifecycle. Meeks et al., (2012) have compiled a strong literature review of work packaging from a construction standpoint and have articulated this literature around six main themes as presented in figure 3.

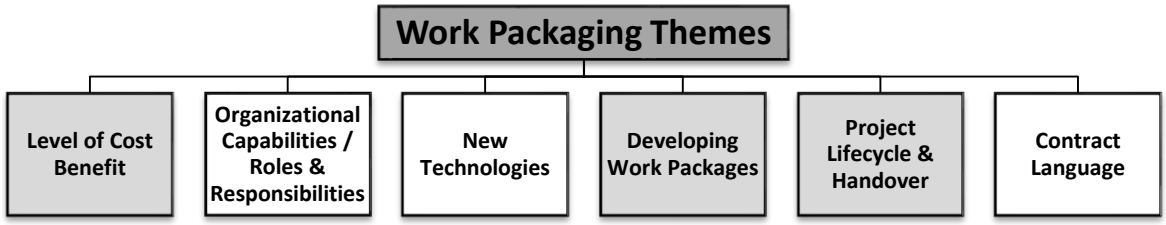


Figure 5 Literature Review framework: Work Packaging Themes (Meeks et al., 2012)

For the sake of having a more complete picture of the work packaging literature in the construction industry, the following section were dedicated to documenting the literature around existing work packaging practices and related implementation evidence within the engineering side of the industry, therefore to be able to depict the major gaps within the literature in term of work packaging.

2.2. WORK PACKAGING FOR ENGINEERING

2.2.1. WORK PACKAGING IN THE ENGINEERING WORLD: ENGINEERING PROJECT MANAGEMENT PRACTICES

Utilizing management tools to manage projects is widely considered a critical component of any project success over any industry. The engineering side of the construction industry is also relating to the management efficiency to its project through a number of organizational theories, practices and tools. In this part of the literature review, we capture how engineering firms are structured, a topic through which relevant information about work packaging can be highlighted. We also present examples of practices used in this field to manage engineering work through levels of development. The way projects within engineering firms are structured is correlated to the engineering firm organization itself (Smith 2008, 221). As far as work packaging of engineering activities are concerned, we can distinguish through the literature the following organizational structure types/strategies:

Generic organization designs:

There are two main generic engineering organizational structures: a structure based on discipline groupings and individual expertise known as a functional multidisciplinary structure and a structure focusing on projects and nature of works known as divisional structure. A functional multidisciplinary structure for engineering firms is a structure that derives its origin from the principle of grouping specialists under one entity. This leads to departments with specific sets of expertise that will tend to "build on specialist skills and dominate the organization through those functions" (Smith 2008). A divisional structure for engineering firms

is in a way a response to what has been challenging with the previous structure: the lack of communication between departments. This structure focuses on the "specialist nature of the work or project rather than individual expertise" (Smith 2008).

The following table (adapted from Smith, 2008) compares the two structures in terms of benefits and challenges:

Table 1 Engineering firms organizational types comparison (Adapted from Smith, 2008)

	Functional multidisciplinary engineering structure	Divisional organization form by type of project
Aim	Build on specialist skills to get information and skills contained through each specialist	Focus on a final product through its type, size, location, customer
Where	Small to medium size companies	Large companies
Decision making criterion	Functional performance	Divisional requirements and corporate priorities
Main Challenge	Lack of integration between specialists, lack of interest and understanding between specialists, impacted communication	Operation inter-boundaries, poor communication, inefficient information exchange

Other structures:

Engineering firms can organize their work and package their activities using other more sophisticated approaches. In fact, the project itself can serve as a temporary organization within the parent organization (Turner and Muller 2003). The advantage of such a structure is its ability to follow the continuous change that a project can see through its lifecycle. However, flexibility can be challenging unless a very qualified engineering project manager is assigned to the project (Hermone 1998). Other structures include networks (Tekeuchi and Nonaka 1995), virtual organizations (Reyck, et al. 2005) and matrix-based structures (Hermone 1998).

Systems and practices: from a fragmented to an integrated approach:

Goodman et al. (1980) highlighted and documented the need to a new approach for project planning and management. Over case studies conducted on projects internationally, they

have identified the most critical problems that are directly related to a fragmented approach to project planning and management. Those problems include the lack of communication between the different people involved with the following groups: project identification and formulation, feasibility analysis and appraisal, design, traditional project management (Goodman and Love 1980). As stated by Goodman and Ignacio (1999), there was found in this study that there was no coordination between and among the groups in charge of those different functions. This is a certain manner emphasizes the need to more coordination, which here validates the need and initiative behind a more collaborative work packaging framework that ensures an integrated approach with the engineering side with all its components and other involved stakeholders in the management of the project in its broader term. Tools for having integrated approaches to engineering construction projects have been developed. For instance, the Integrated Planning and Quality Management System (IPQMS) is a "conceptual tool for observing and analyzing the process of projects in all sectors" (Goodman and Ignacio, Engineering project Management 1999) .

2.2.2. OBSERVATION

Engineering Work Packaging and organizational structures:

It is true that the organizational structure goes beyond the definition of work packaging as a process defining the units of work to execute. However, it remains clear that the type of structure defines the process of work breakdown for engineering firms. More detail regarding this relationship can be presented through the literature of planning processes for Engineering and the process of incorporation of other stakeholders' schedules into the main project schedule.

Communication as a main challenge:

Although no explicit use of engineering work packaging terminology is common in literature, there is a good descriptive literature of the engineering firms' organizational structure which is determinant of how the engineering work is packaged. We can also perceive a consensus on the increasing importance of the engineering project manager in achieving

effective inside work packaging and design efficiency. In addition, for almost all organizational types, including the most integrated ones, communication between 'departments' or ‘specialists’ is considered as a big challenge. This challenge has been the main driver for developing more advanced and integrated structures as the matrix structure (Hermone 1998). This challenge extends from the early design stages regarding the development of the WBS to the late stages of drawings finalization and review. To overcome this challenge, there is some literature developed around what we can consider as set of rules to improve communication within an engineering firm (Hermone 1998) (P. D. O'Connor 1994) (Goodman and Ignacio, Engineering project Management 1999) (Smith 2008).

2.3. WORK PACKAGING AND PROCUREMENT

2.3.1. WORK PACKAGES AS PROCUREMENT SUB-SYSTEMS

The literature contains two main groups of research on work packaging and procurement: the first group is related to researchers who focus on procurement as the center of their work and develop around practices, concepts and methods. The second group of researchers would contain all the people that by focusing on another topic such as constructability or productivity and relate to procurement and work packaging as part of the entire picture of their research. Both groups contain interesting perspectives about the topic and allow the drawing a relationship and connection between work packaging and procurement. However, there is no explicit research about work packaging as previously defined and procurement.

As mentioned by (O'Connor, Rush and Schulz 1987) "work packaging is particularly critical for a fine-tuned construction driven schedule, and it must be developed at a fairly detailed level to be effective". The consensus about the fact that constructability is enhanced when driven by both design and procurement makes work packaging in direct relationship with procurement for successful projects experiences. O'Connor et al. (1987) laid the ground for the importance of construction-driven schedules in enabling prioritization of engineering and procurement and effectiveness of work packages. As far as some specific applications of this with respect to procurement and work packaging, the authors recommended the following: "the design schedule for engineered equipment should be driven by the procurement schedule, which is construction-driven". This emphasizes as far as work packaging is concerned the importance of aligning construction and procurement plans and schedules.

Standardization is also considered as a source of enhancement for project management practices and steps. The impact of standardization through work packaging on procurement is recognized by the same authors as leading to a "simplified material procurement".

In the same context of efforts of conceptualizing work packaging techniques for procurement, Kumaraswamy and Dissanayaka (2010) worked on assessing the impacts of various procurement variables on project performance, in comparison to the impacts of non-

procurement related variables, such as project conditions and team characteristics. Their framework was based on "a holistic overview of procurement systems that included, for example, sub-systems of work packaging, and type of contract." The authors general procurement framework is composed of a number of construction project procurements sub-systems which are:

1. Work packages
2. Functional groupings
3. Payment modalities
4. Form of contract
5. Selection methodologies

The following is an excerpt from the publication explaining work packages as procurement sub-systems:

> "Work packages may be designed to be large enough to attract international interest, if needed for purposes of greater price competition, or for deploying advanced technologies economically (for example, if special expertise was needed to design and or build complex structures such as double-curvature arch dams or tunnels in poor ground conditions). Alternatively, the large and or complex work packages may be 'sliced', to keep them within the capabilities of local construction organizations. For example, 'vertical' and or 'horizontal' slicing is possible on a road works project, by dividing it into different projects along the length of the road and or into separate parcels for earthworks, surfacing and services, respectively (Kumaraswamy and Dissanayaka, 1997)" (Kumaraswamy and Dissanayaka 2010)

2.3.2. OBSERVATIONS

Coordination and proper communication is a main challenge

In most projects, construction procurement services are packaged with other architectural services such as design, construction documents, or construction contract administration (The American Institute of Architects 2000). Taking into consideration the fact that procurement is directly correlated to the sequence of construction, proper coordination between the construction side and procurement side which can be the engineering side too seems to be inevitable and vital for project success. The literature recognizes problems caused by the lack of coordination and

integration of procurement with construction. The need for an integrated system allowing the proper means of communication and coordination is established. Solutions proposed in the literature range from technological systems to management systems.

2.4. RESEARCH QUESTIONS DEVELOPMENT

2.4.1. LITERATURE GAPS

Within the literature review briefly presented previously, we can extract two major literature gaps:

In terms of project stakeholders, there is better evidence (more detailed and current) around work packaging practices and implementation challenges for Construction than for Engineering. Thus, there is value in documenting existing engineering work packaging practices in relationship with the construction side of projects.

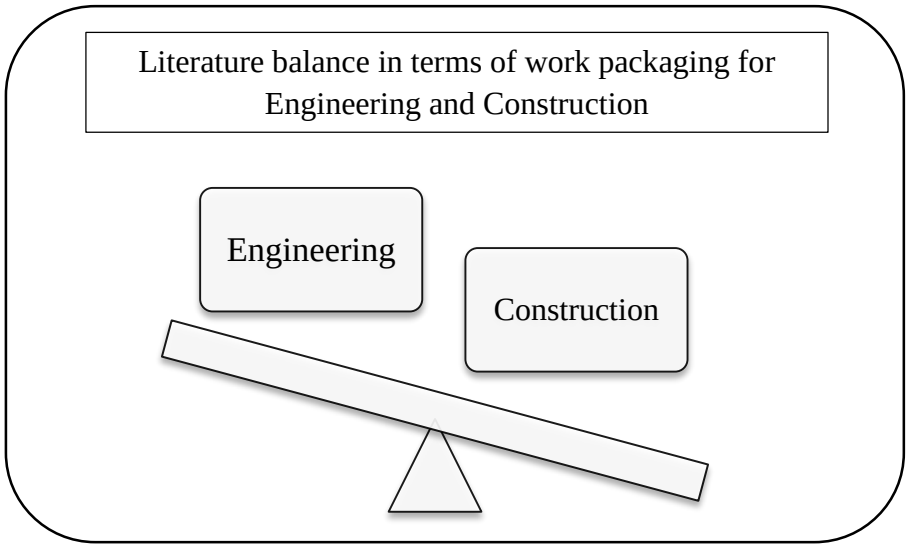


Figure 6 Literature Gap

In terms of project phases and implementation processes, there is better evidence for work packaging challenges during the construction phase than during the Front End phase. It is

important to mention that this observation is made independently of the reasons causing this literature gap. In addition, the literature on engineering work packaging processes might overlap with any research findings regarding the Front End phase and work packaging. This overlap, if existing through the research findings, consolidates the picture we aim to draw of work packaging through the project lifecycle as experienced by major project stakeholders.

2.4.2. RESEARCH QUESTIONS AND SCOPE

Scope definition: Use of CII/COAA RT 272 new terminology of Advanced Work Packaging (AWP): we use this term to be able to cover the definition of a work packaging process integrating all the project lifecycle (especially in the Front End) and involving major stakeholders from Engineering to Construction.

Geographical focus: North America: this geographical boundary of the study is implied by the research methodology requirements (e.g., data availability, experts' access). However, as companies are operating on a global scale as well as the degree of globalization of the construction industry being studied in different parts of the world, the literature review as well as the research findings contain

Main research question implied by the literature gap and defined scope:

Having examined the literature gaps in combination with the documented need through the RT 272 charter, this thesis is structured to respond to two research questions:

1. How can we model Advanced Work Packaging through the three project phases?
2. What are the challenges experienced by firms implementing Advanced Work Packaging processes in North America?

Question 1 addresses the need for an integrated work packaging structure that covers the project lifecycle. This question, being deeply studied by the research team RT 272 through a 4 year project, is answered through the following chapters with the presentation of the research team findings as well as the results from expert interviews conducted to investigate the current

standards of practice in the industry. Sub questions to research question 1 are: a) what are the existing work packages practices for Engineering and Construction? And b) what recommendations can we gather and develop based on the current industry status regarding work packaging?

Question 2 is related to the implementation side of work packaging. This aspect of work packaging is related to the experienced levels of Advanced Work Packaging implementation in projects. Question 2 is depicted through the description of contracts, organization and processes of AWP implementation through the following chapters. The description highlights the experienced and expected benefits as well as the experienced challenges.

CHAPTER 3. RESEARCH METHODOLOGY

The research objectives and methodology related to phase 1 can be found in phase 1 research report RR 272-11, The transition from phase 1 to phase 2 was accompanied with changes not only in the team members as a result of the joint venture but also in objectives; therefore, giving place to a designed methodology to achieve the new goals. As stated previously, those objectives are:

1. Elaboration of process to support implementation built from phase one deliverables on process descriptions and COAA swim lane charts. Alignment of definitions among COAA and CII documentation is part of this topic.
2. Development of contractual requirements and contracting strategies
3. Development of a maturity assessment to aid general appraisals of implementation quality and help firms and projects identify where to focus implementation efforts.

Achieving those goals relies on: joint and collaborative team work, and continued feedback and input from industry, supporting empirical data collection.

To satisfy the objectives, the team developed the research in three phases: Charter Formation, Development, and Deliverables. These three phases and associated sub-phases and research methodologies are depicted in Figure 1and explained in detail in section 3.1 through 3.3.

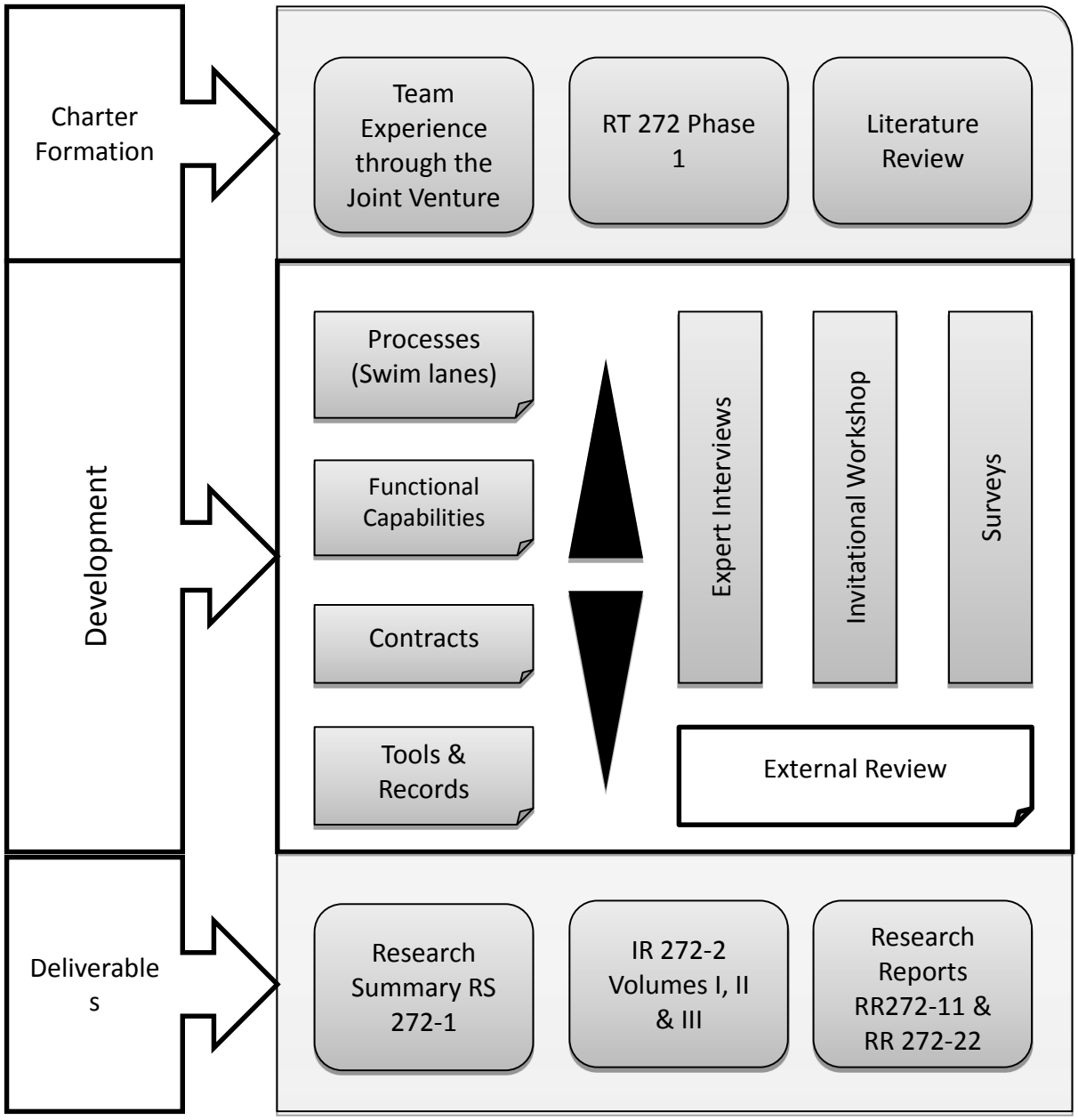


Figure 7 Research phases and methodology (2011-2013)

3.1. RESEARCH PHASE 1 – GAP IDENTIFICATION & CHARTER FORMATION

In the first stage of the research process of phase 2, the team focused on developing its charter meticulously in a way that reflects the joint venture and prior art of the studied subject: Advanced Work Packaging. The charter formation phase extended mainly through the first two face to face meetings. This phase satisfied the objective of identifying the gaps of the literature (including the team previous work during phase 1) and addressing those gaps through a working plan for phase 2.

3.1.1. RESEARCH TEAM EXPERIENCE

The team as described in its research summary RD 272-1 is: “composed of experts in leading work packaging methods, as well as personnel with detailed knowledge of engineering processes and other construction processes, e.g., materials management and project controls (see Figure 8 and Figure 9). The team also had strong representation from both owner and contractor organizations (see Figure 10). As such, the team was uniquely positioned to create a recommended model of Advanced Work Packaging that spans all project phases, from definition through construction and turnover. The team also benefited from its awareness of contemporaneous efforts related to Advanced Work Packaging—in particular, the WorkFace planning development carried out by the Construction Owners Association of Alberta (COAA) (see Figure 11). COAA's leading development of WorkFace planning (WFP) provided the basis for specific recommendations for field practice as well as a starting point for an approach to work packaging across the project lifecycle.”

The joint venture has been recognized as an asset and a key success factor to the teamwork. Indeed, this was also reported in a number of the team meeting minutes as showed in the following extracts of the team feedback over the dynamics of its face-to-face meetings and research work:

"The Joint work was a source of enriching experience" (Meeting minutes of March 2013)

“Excellent leadership and focus among sub teams" (Meeting minutes of January 2013 meeting)

“COAA/CII formation is stronger and more visible through this research team joint venture" (Meeting minutes of September 2012 meeting).

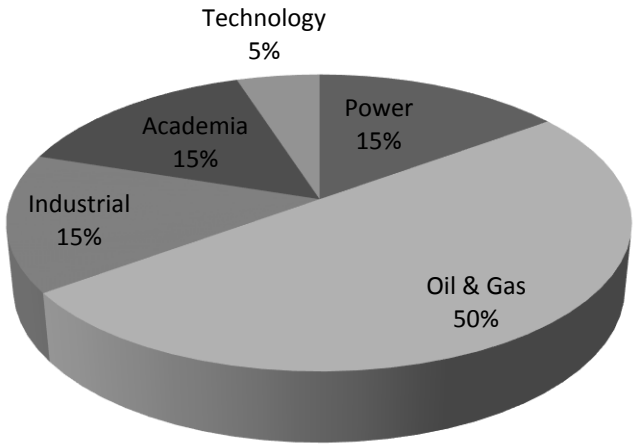


Figure 8 Team representation – industry

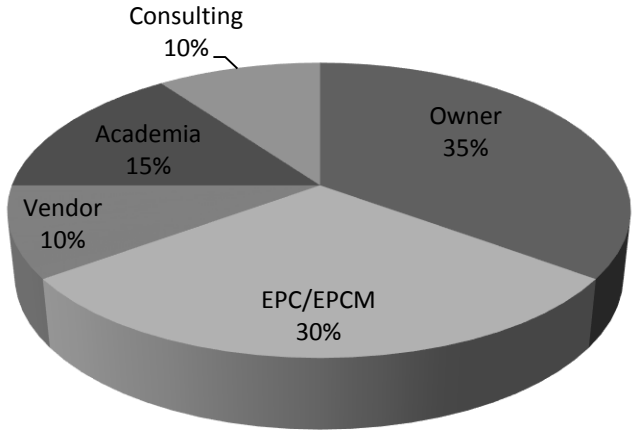


Figure 9 team representation - firm type

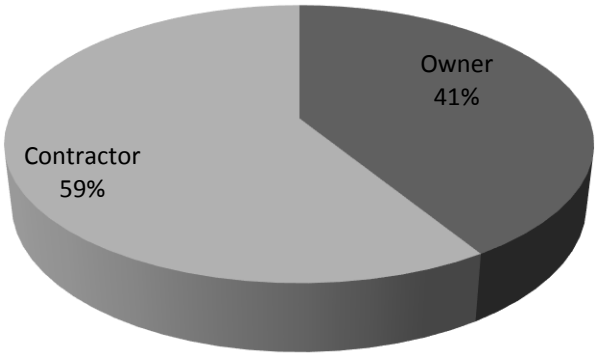


Figure 10 team representation - owner v. contractor

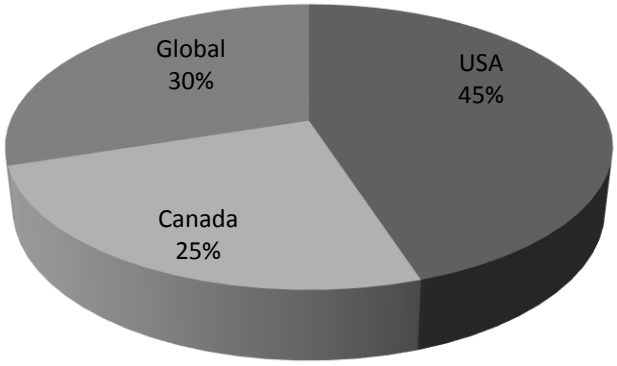


Figure 11 team representation – location

As presented by the range of figures representing the team composition per several criteria, the team enjoyed both a breadth and depth of experience related to work packaging in addition to a keen interest in the subject and commitment to advance the industry.

The team members interacted through not only face-to-face meetings that were held regularly approximately every other month, but also through conference calls scheduled in between face-to-face meetings. During the first meetings, the team worked on:

Reviewing the feedback received from the implementation session of phase one during the CII conference; this feedback consisted of the attendees comments and recommendations to the team for future work.

- Aligning CII and COAA members visions and building a common ground for success
- Deciding on which deliverables are needed to further enhance the process
- One of the main outcomes of those early meetings and discussions was: the need to have "implementation" as a key driver of the team phase 2 work. In fact, it has been agreed on that there is a critical need to move work packaging resources to a more implementation-oriented guidelines that can be used as "ready to implement".

3.1.2. RT 272 PHASE 1 & LITERATURE REVIEW

As a starting point for phase 2, literature review was not as extensive as for phase 1 where the team started from scratch. Prior work and deliverables of phase 1 team were in the center of discussion during the first meeting. The "Enhanced Work Packaging" document (Implementation Resource – see Figure 12) and COAA documentation available on its website (see Figure 13) were the main pre-requisite for every team member.

Figure 12 RT 272 Phase 1 deliverable

Figure 13 COAA Website (http://www.coaa.ab.ca)

3.2. RESEARCH PHASE 2 – DEVELOPMENT

3.2.1. WORKING THRUST AREAS

The research phase 1 that consisted into the charter development led to the identification of three main thrust areas that the team decided to structure its work on AWP around. Those thrust areas are:

1. Process
2. Contracts
3. Functional Capabilities

For each thrust area, a sub-team was composed. Team members joined sub-teams based on their preferences, however, through the development stage, few members joined different teams depending on the need. At a later stage, each deliverable of every team was reviewed by the entire team and feedback was given to each sub-team.

- Face-to-face meetings dynamic in the development phase
- There were breakdown sessions during face-to-face meetings.
- During each face-to-face meeting, the team starts by "sub-team updates" section which is a time reserved for each team leader to update the entire team on its sub-team progress.
- At a later stage of the development phase, each sub-team deliverables were reviewed by the entire team and feedback was incorporated. Also, as tools included not only tools directly related to each trust area but to a "cross sectional" area which is the maturity assessment, the functional capabilities sub-team moved to working on the maturity assessment tool.

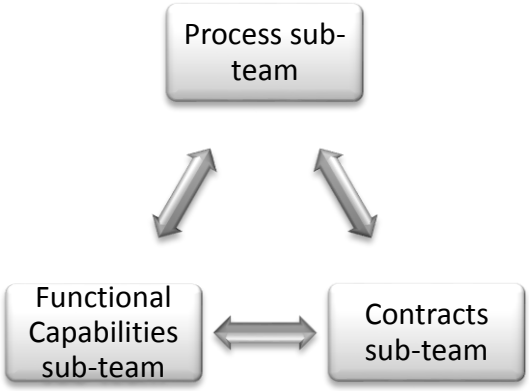


Figure 14 Development thrust areas and interactions

The findings for each thrust areas are detailed in the chapters four, five and six.

3.2.2. TOOLS

The team has worked on developing the following tools: 1) Maturity Assessment tool; 2) AWP Audit tool; 3) Project Definition Assessment; and 4) Job Descriptions.

Each of those tools was developed through several stages. The motivation behind developing tools is driven by the fact that the team wants to help the reader and user of the implementation resource best implement the Advanced Work Packaging model. Those tools are meant to be used by different persons. They are not prescriptive and can be a source of inspiration to companies too.

Below are extracts from the Implementation Resource IR 272_2 volume III defining the purpose and the utility of each of the developed tools:

- Maturity Assessment

  […] The Advanced Work Packaging Maturity Assessment Model (Maturity Model) can be used by companies or projects to assess their current state of AWP / WFP implementation. The Maturity Model is divided into three levels, representing beginning to accomplished levels of implementation maturity. […]The Maturity Model assesses an organization's AWP / WFP integration status at three levels and across multiple functions that support capital project execution.

- AWP Audit tool

The AWP Audit tool is meant to assess conformity to the AWP processes at each stage of the project. It is primarily for use by the Owner but can also be used by other parties to identify gaps in AWP implementation. Suggested assessment timings are included as steps in the AWP Project Integration Flowcharts

- Project Definition Assessment

An AWP Project Definition Assessment Tool is provided to help project teams assess readiness before starting AWP implementation on a specific project. The tool is divided into different organizations/functional roles: Owner, Project Management, Construction Management, Engineering Contractor, Supply Chain Management, and Construction Contractor.

- Job Descriptions

In conjunction with the AWP Project Integration Flowcharts (PIF), the team has developed a set of thirty-two role/job descriptions. These are descriptions for each of the functional organizations designated in the PIF; each task on the PIF shows which job/role description is responsible for that box.

3.2.3. EVIDENCE COLLECTION

3.2.3.1. Expert interviews

Figure 15 Timeline of interview findings report to the team

In parallel to developing an Advanced Work Packaging (AWP) Implementation Guidance, the research team RT 272 has documented, expert interviews, the industry work packaging status and general trends. The collected evidence presents an overview of the current North American construction industry work packaging practices, perceived benefits and experienced implementation challenges through the entire project lifecycle. The research team,

during its two research phases, has used those findings to: 1) refine its objectives, 2) enhance the quality of its deliverables, and 3) assure its work is aligned with the industry need.

Scope of projects

Members of RT 272 provided the network of contacts for the seven case studies and nineteen expert interviews. Data and information were collected through site visits, home office interviews, phone interviews and published corporate resources. Two questionnaires (Validation interviews questionnaire) were used to conduct the case studies and the set of expert interviews. Documented projects were in Brazil, USA, Canada and Australia. The projects and companies selected for review represent a range of industrial and commercial construction sectors, including power, oil & gas, government, and commercial projects. The case studies are detailed in the Research Report RR 272-11 of phase 1 developed by Sarah Meeks, the graduate research assistant for phase 1. Interviewed experts represent a range of owners and contractors. These projects and companies have different work packaging maturity levels. Finally, the companies studied and experts interviewed have been kept anonymous.

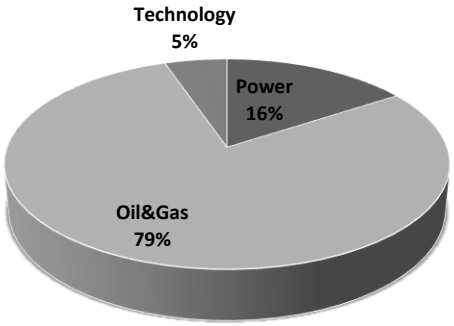


Figure 16 Expert interviews per sector

Table 2 presents the list of interviewed experts during the second phase of the research work. Those people were contacted through the team members and other industry experts supporting the research teamwork. For instance, during the CII Annual conference in Baltimore of July 2012 and during the COAA invitational workshop in Canmore of September 2012, few

experts and consultants volunteered to be interviewed to contribute to the team feedback collection process.

Table 2 Expert Interviews

	Company Coding	Sector	Company Type	Expert function
Expert Interview 1	A	Energy (Oil & Gas)	EPC	Vice president
Expert Interview 2	B	Energy (electric utilities)	Owner	Project Engineering Supervisor
Expert Interview 3	C	Energy (nuclear)	Owner	Manager of nuclear projects
Expert Interview 4	D	Industrial (refinery)	EPC	Project Manager
Expert Interview 5	D	Energy	EPC	Consultant - WFP planner
Expert Interview 6	D	Industrial (Refinery)	EPC	deputy construction manage

Table 2 (continued)

Expert Interview 7	E	Energy (Oil & Gas)	Owner	Construction WF manager
Expert Interview 8	F	Energy (Oil & Gas)	Consulting	Consultant WFP
Expert Interview 9	G	Energy (Oil & Gas)	EPC	Construction manager
Expert Interview 10	H	Energy (Oil & Gas)	Owner	Project controls and infrastructure oil sands
Expert Interview 11	I	Energy (Power)	Owner	2 Project Engineering Team Leads for Process & Tools
Expert Interview 12	I	Energy (Power)	Owner	Project engineers
Expert Interview 13	J	Energy (Oil & gas)	EPC	WFP manager

Expert Interview 14	K	Energy (Oil & Gas)	EPC	Chief Operating office - VP Project Management Office
Expert Interview 15	L	Energy (Gas producer)	Owner	Construction and construction engineering manager
Expert Interview 16	E	Energy (Oil & Gas)	Owner	Project manager
Expert Interview 17	E	Energy (Oil & Gas)	owner	Construction manager
Expert Interview 18	M	Energy (Oil & Gas)	EPC	System and integration manager
Expert Interview 19	N	Various construction sectors	Consulting	Director

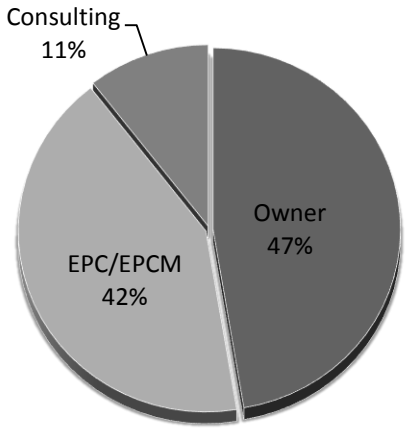


Figure 17 Expert Interviews representation - Firm type

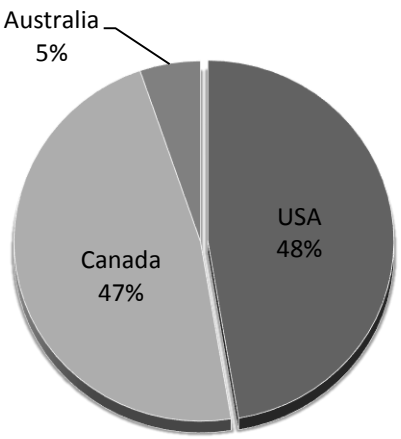


Figure 18 Expert Interviews representation - Project location

The interview average duration was 55 minutes. The interview was a semi-structured interview; which means questions were open for discussion and allowed the interviewee to not only respond directly to the question but also extend their response to examples and other related topics as needed. The interview questionnaire (see Figure 20) is a generic questionnaire. Since interviewees have different backgrounds and are involved with different levels in their respective companies, some questions were asked and customized to the interviewee.

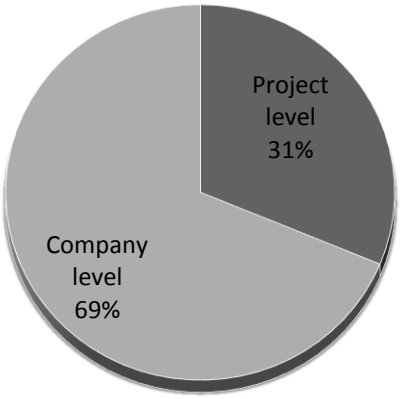


Figure 19 Interview representation - level of implementation discussed

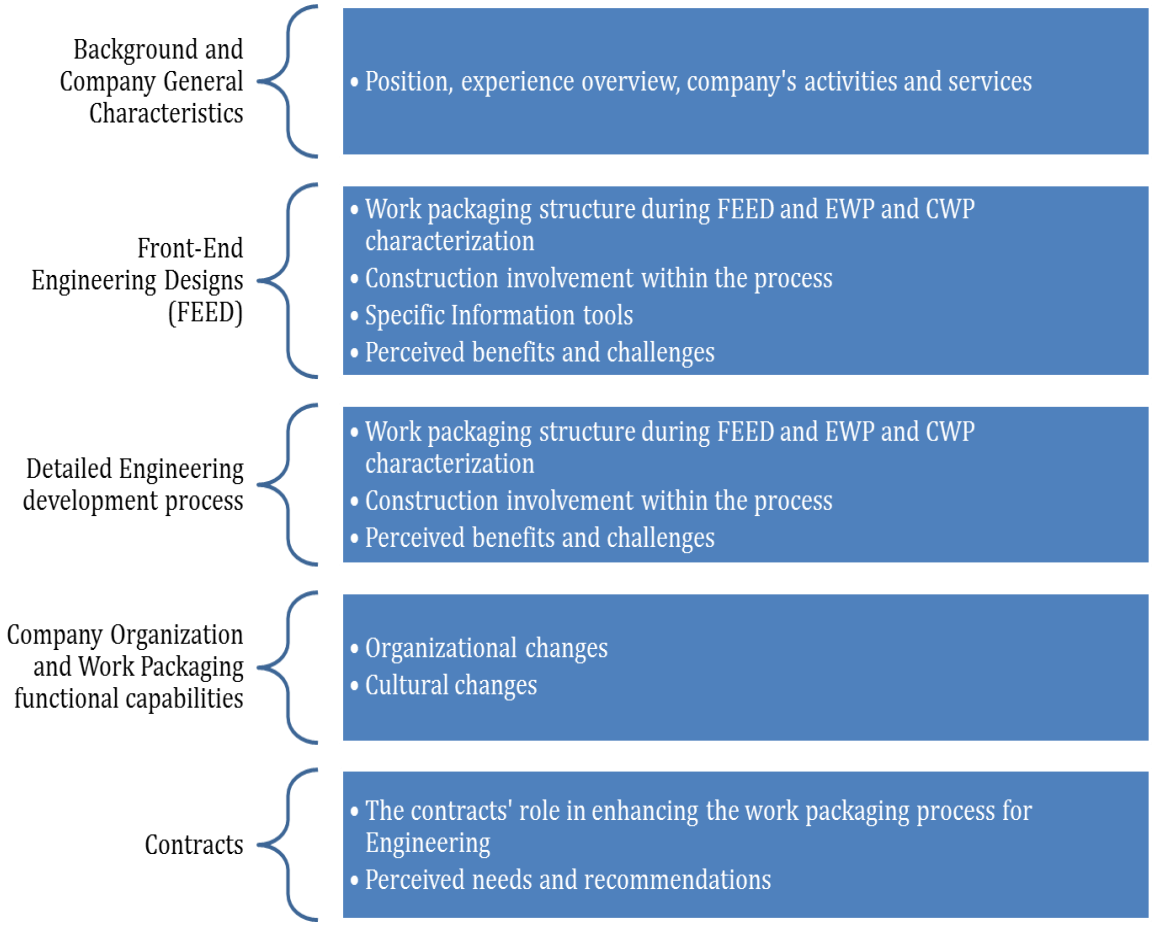


Figure 20 Interview questionnaire group of questions

3.2.3.2. Invitational Workshop

This workshop is on invitation basis. It is organized by the Construction Owners Association of Alberta. It took place on October 2012 in Canmore Canada. About 35 people attended the workshop. Invitees were all experts in WorkFace Planning implementation and had experience with using this work packaging system. The objective of the workshop was to explore barriers to implementing Advanced Work Packaging through experts' experiences in implementing WorkFace Planning. The main two objectives are as follows:

→ Help RT 272 better deliverables and come up with topics of discussion for COAA AFP conference Sept 2013

→ Find top barriers

The group of experts included a diverse group, including owners, engineers, and WFP software specialists. The choice of an invitational workshop aimed to target people who have a diverse representation and to be able to benefit from their individual experiences. The workshop was divided into two main parts in order to achieve the objective of identifying barrier to AWO implementation.

Part 1: Identifying barriers

The group of experts was divided into 4 teams with 4 facilitators and they had as objective to determine list of barriers, rank their top 10 based on the largest effect on project outcome. Each team reported then those set of challenges or problems with a problem statement over the top 3. A problem statement is articulated around answers to the following basic questions: What? where? How? When? Who?

Part 2: After report out

This included a collective vote to get top 6 barriers. Results of the workshop are reported in the following chapters as to document findings and support them. Appendix XX contains a summary of the workshop minutes and details of each sub-team findings.

3.2.3.3. Surveys

The team proceeded to putting together a survey that was used both online through CII survey tool and during an implementation workshop during the COAA Best Practices Conference in Edmonton in May 2012. The number of combined surveyed people is 68. The following figures show characteristics of the surveyed population.

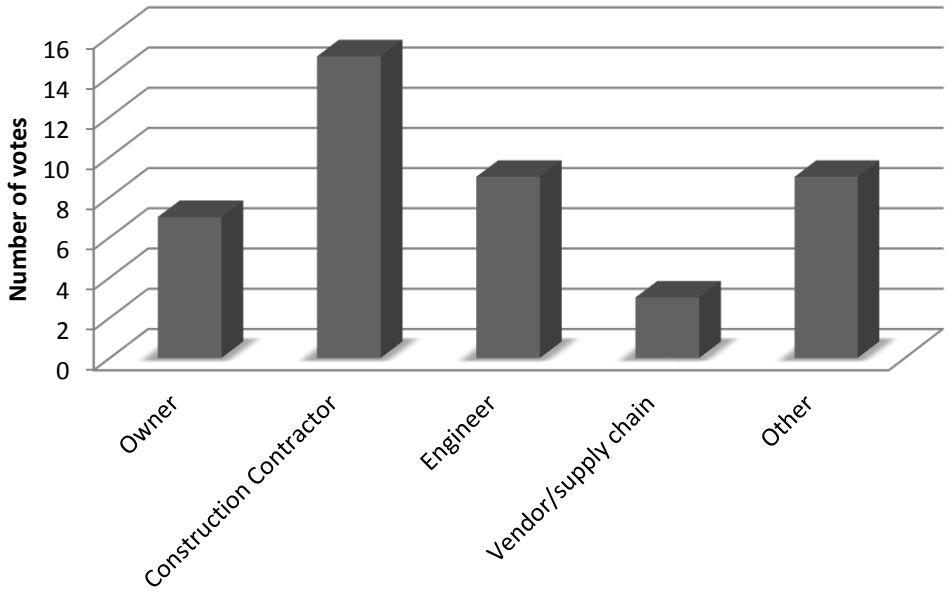


Figure 21 COAA Best Practices Conference & Online survey- Survey results to Q1: Who are you?

Question 1 showed that the audience, on the image of the team, is composed of people from various stakeholders in the construction industry. This contributes to the essence of the research project that is figuring out a framework that enables all different stakeholders operates to optimize productivity and predictability.

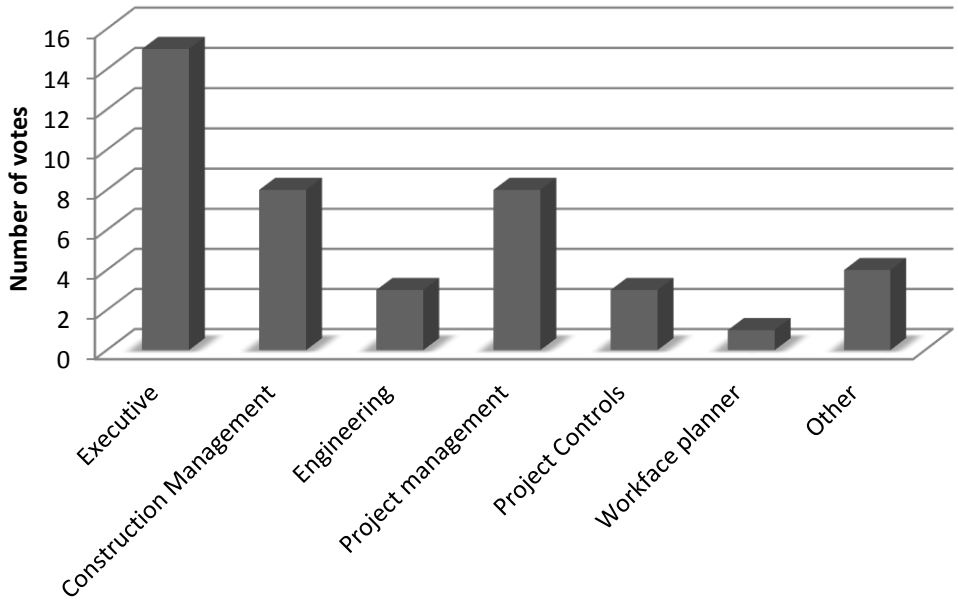


Figure 22 COAA BEST PRACTICES Conference & Online survey - Survey results to Q2: What is your role in the company?

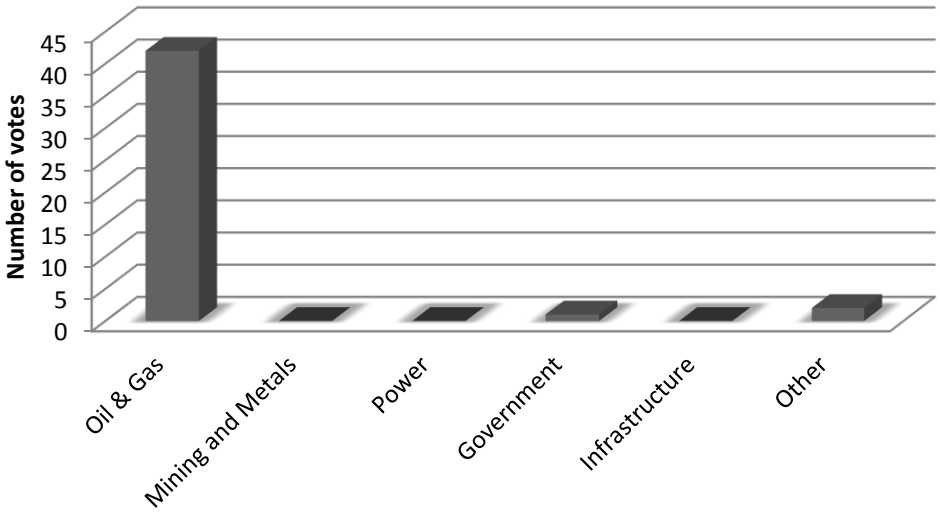


Figure 23 COAA BEST PRACTICES Conference & Online survey - Survey results to Q3: What is your main business?

The survey detailed questions are in

COAA Best Practices conference survey results. The survey results were used to not only validate the team research direction but it was also a basis for discussion during team face to face meetings. The survey results also played the role of stimulator for the team intellectual production and thinking over the subject of the research.

3.2.4. EXTERNAL REVIEW

Validation of the research deliverables consisted of external feedback collection by industry experts. Six experts, including one group of experts, outside of the research team were interviewed to provide validation. The experts reviewed the recommendations and findings of the team and participated in a 30 minutes to one-hour interview with the academic team members to discuss their impressions. The interviews were guided by an interview guide, presented in Validation interviews questionnaire, which focused on capturing the reader's understanding of the research findings and their impressions of the practicality and value of the model and work packaging recommendations. The validation feedback was utilized to refine and support the research findings. Each interview was summarized into an anonymous report, all of which are presented in Validation interviews write-ups.

The total industry experience represented by these experts is 202 years, with an average of 33 years.

Table 3 Background Summaries of Validation Experts

ID	Area of Expertise	Type of Company	Years of Experience
Expert V1	Engineering	EPC	42
Expert V2	Research	Academia	42
Expert V3	Construction	EPC	21
Expert V4	Project Management	EPC	33
Expert V5	WorkFace planning	Consulting	21
Expert V6	Construction	Owner	43

3.3. RESEARCH PHASE 4 – DELIVERABLES

Following development with external continuous review, the team recorded the research findings in four CII deliverable documents:

Research Summary (RS 272-1): written by both academics and industry team members to provide a high-level overview of the research findings

Three volume Implementation Resource: written by both academic and industry team members and documents the work packaging model findings, including the definitions, execution model, and tools

- Implementation Resource 272-2, Volume I, Advanced Work Packaging: Design through WorkFace Execution,
- IR 272-2, Volume II, Advanced Work Packaging: Implementation Guidance, and
- IR 272-2, Volume III, Advanced Work Packaging: Implementation Case Studies and Expert Interviews
- Two Research Reports (RR 272-11 and RR 272-22): written primarily by the academics that conducted the interviews and documented the case studies and expert interviews.

In addition to presenting the research findings, the implementation resources provided guidance to companies around effectively implementation of work packaging practices. Finally, the RR 272-22 was written by the academic team members to document the research process and findings.

CHAPTER 4. PROCESSES

Advanced Work Packaging process developed by the research team RT 272 included the following items and steps:

- The alignment of definition around work packaging between booth the Construction Industry Institute and The Construction Owners Association of Alberta,
- The development of Lifecycle flowcharts,
- The development of swim lanes, which are a tool to summarize Advanced Work Packaging in a very practicable and implementation oriented manner,
- Implementation tools such as the Maturity Model and audit tools, and
- Case studies report and summary of expert interviews.

This chapter aims to present the team findings about the actual process of Advanced Work Packaging execution as well as an overview of the industry status regarding implementation practices. The chapter is divided into 4 main parts:

1. Definitions that will present to the reader an overview of the main concepts behind Advanced Work Packaging,
2. Flowcharts and supporting tools that will present the details of the model and the team deliverable for implementation,
3. The Maturity Model part which will not only present the purpose and usefulness of this tool but also its content, and
4. The state of the art of Advanced Work Packaging industry implementation and experience through an ensemble of evidence gathered through case studies and expert interviews.

4.1. DEFINITIONS

The essence of AWP is conveyed in the Figure below. The figure shows two main overlapping parts of the Advanced Work Packaging lifecycle: the Front End Engineering Design (FEED) part along with the Detailed Engineering (DE) phase from one side and the WorkFace planning (WFP) part from the other side. (Institute and Construction Owners Association of Alberta 2013)

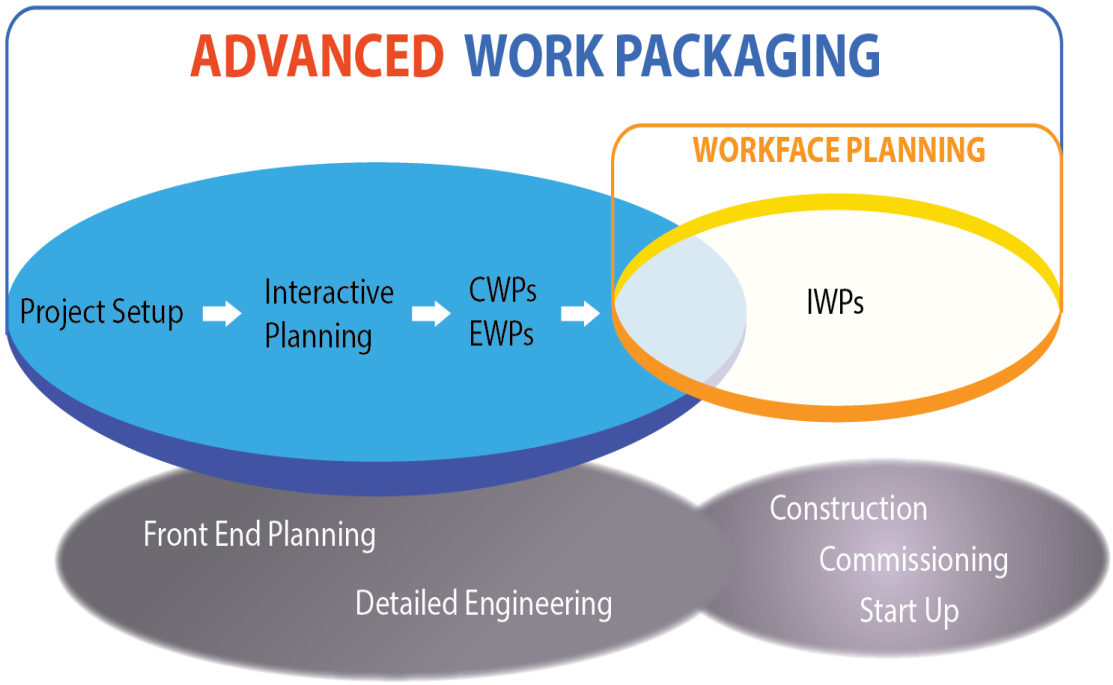


Figure 24 Advanced Work Packaging model

Research Team RT 272 defines Advanced Work Packaging in its main implementation deliverable as follows:

> Advanced Work Packaging (AWP) is a disciplined approach to improving project productivity and predictability. It accomplishes this by aligning planning and execution activities across the project lifecycle, from project setup to startup and turnover.

AWP is a more complete set of work packaging practices than WorkFace Planning. It covers not only construction but also the early stages of the project and adds to the system more control over the breakdown of the project through its lifecycle. Items mentioned within the blue and yellow circles are key project deliverables all through the advanced Lifecycle. CWPs, EWPs and IWPs are respectively acronyms for Construction Work Packages, Engineering Work Packages and Installation Work Packages. Below are experts from RT 272 set deliverables that will define every term:

The definitions developed by the research team are presented below in their entirety from the Implementation Resource IR 272-1 volume 1, *Advanced Work Packaging: Design through WorkFace Execution*, which presents the basic concepts and definitions and lays out a recommended execution model in three stages – planning, detailed engineering, and construction.

> **Work Packaging:** Work packaging is the overall process flow of all the detailed packages. It is a planned, executable process that encompasses Engineering Procurement and Construction's (EPC) detailed design through execution. Work packaging provides the framework for productive and progressive construction. Work packaging presumes the existence of a construction execution plan.
>
> **Work Face Planning:** Work face planning is the process of organizing and delivering all the elements necessary, before the work is started, to enable craft persons to perform quality work in a safe, effective, and efficient manner. This is accomplished by breaking down (planning) construction work by trade into discrete work packages that completely describe/cover the scope of work for a given project to efficiently use available resources and track progress.
>
> **Work Face Planning Lead:** A Work face planner is a person identified to participate in project front-end planning that thoroughly understands EPC projects, who will later transition onto the jobsite and provide the essential coordination among engineering, procurement, and construction that ultimately results in timely issuance of a complete and constructible Installation Work Package (IWP) that supports the construction schedule. This person will lead a staff of work face planners that is sized according to the scope and complexity of the project and that have sufficient understanding of construction to prepare discipline specific IWPs with the required support from other departments and approval from construction management.
>
> **Work Breakdown Structure:** WBS is a hierarchical representation of a complete project or program, its components being arrayed in ever-increasing detail (CII, 1988).

Engineering Work Package: An engineering work package (EWP) is an engineering and procurement deliverable that is used to construct Construction Work Packages (CWP). The EWP shall be aligned with construction sequence and priorities.

Construction Work Package: A construction work package (CWP) defines a logical and manageable division of work within the construction scope. The CWP is aligned with the project execution plan (which includes the construction plan) and WBS. The division of work is defined so that CWPs do not overlap. CWPs are to be measureable and in alignment with project controls. CWPs are the basis for the development of detailed installation work packages. CWPs can contain one or more EWPs. A CWP is typically aligned with a bid package.

Installation Work Package: An installation work package (IWP) is the deliverable to a construction work crew that enables a crew to perform quality work in a safe, predictable, measurable, and efficient manner. An IWP is scoped to be manageable and progressable, typically of limited size such that a crew can complete the work in about a week. An IWP contains necessary documentation supporting work face execution. An IWP has been approved by the responsible stakeholders and constraints have been mitigated before being issued to the field.

4.2. FLOWCHARTS

4.2.1. LEVEL 1 FLOWCHART

Based on team experience, literature review findings, and case studies, the research team developed in its phase one an integrated execution model describing the implementation of work face planning through the lifecycle of a project, from project definition through system turnover. This execution model is presented below in Figure 20

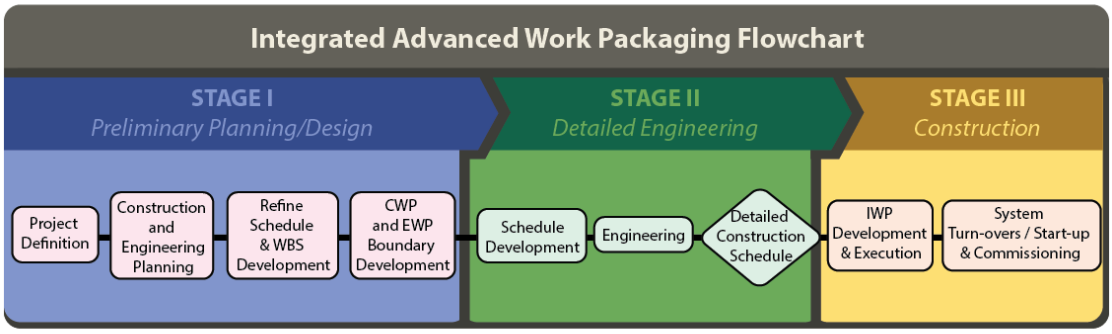


Figure 25 Integrated Advanced Work Packaging (AWP) Flowchart

The execution model covers three stages of construction project lifecycle: stage I: preliminary planning / design, stage II: detailed engineering, stage III: construction.

Stage I: Preliminary Planning/Design

An excerpt from the Implementation resource IR 272-2 Volume I, describing Stage 1, Preliminary Planning/Design, is presented below:

> Stage I presents several detailed challenges for organizations seeking to maximize the benefits of enhanced work packaging. The concepts in stage one include consideration for work packaging in the early stages of project definition with explicit consideration of things such as construction sequence and level of details of design. Also central to stage one is the coordinated planning of construction and engineering through specification of construction work packages (CWPs) and their sequence. From this early definition of CWPs, engineering work packages (EWPs) should be developed to be contained within CWPs, and engineering execution should be planned accordingly to support construction. This presents a challenge to traditional engineering that is accommodated by system or discipline and crosses traditional CWP boundaries. Effective planning here will direct engineering to support construction on fast-track projects -- ideally without causing unnecessary engineering expense. Early planning with the right expertise is central to successful execution in subsequent stages. Thus, a key message for owner organizations conducting preliminary planning and design is to ensure that the right expertise is available even if contractors and vendors have not been selected.

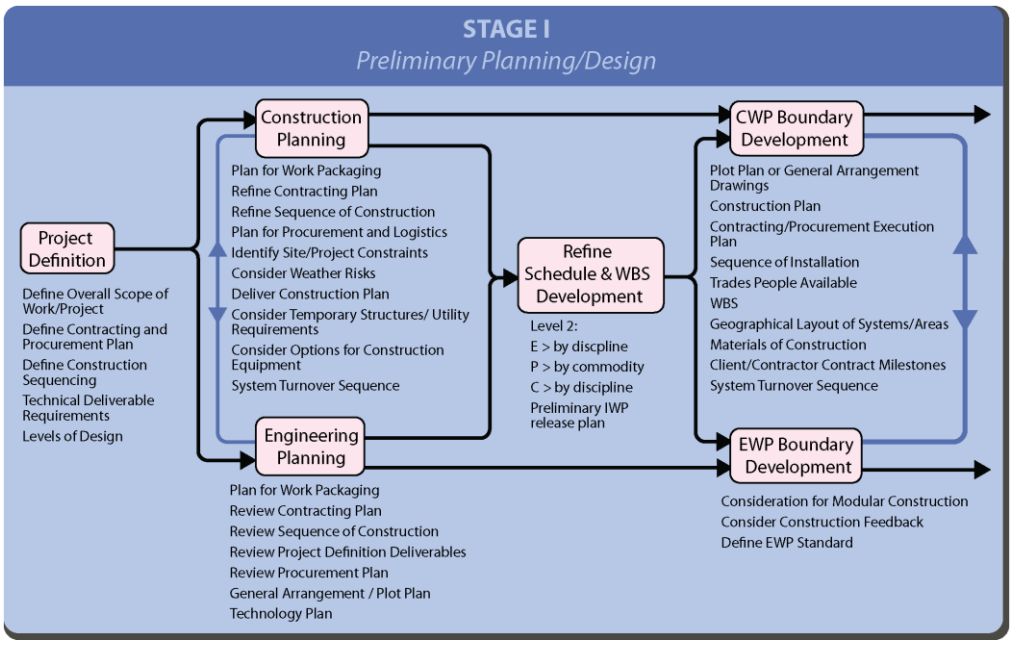


Figure 26 Stage 1 Flowchart - Preliminary Planning/Design (CII, 2011b)

Stage II: Detailed Engineering

An excerpt from the Implementation resource IR 272-2 Volume I describing Stage 2, Detailed Engineering, is presented below:

> Stage II presents a challenge for traditional construction organizations that are not set up to perform enhanced work packaging. Traditional construction organizations that allow field supervision -- superintendents and foreman -- to perform all detailed planning may be allowing informal planning processes. The enhanced work packaging model prescribes the use of a work face planner apart from the foreman role. A work face planner as noted in the definition above has responsibility for designating and managing installation work packages (IWPs). This means advanced planning and analysis and release of potential constraints. Management of IWPs is not performed separately from the field but rather in conjunction with field supervisors. Field supervisors are able to spend more time managing the work and have been relieved of the burden of detailed planning. The work face planner performs the detailed planning and supporting coordination tasks and gets input and signoff from the field supervisors.

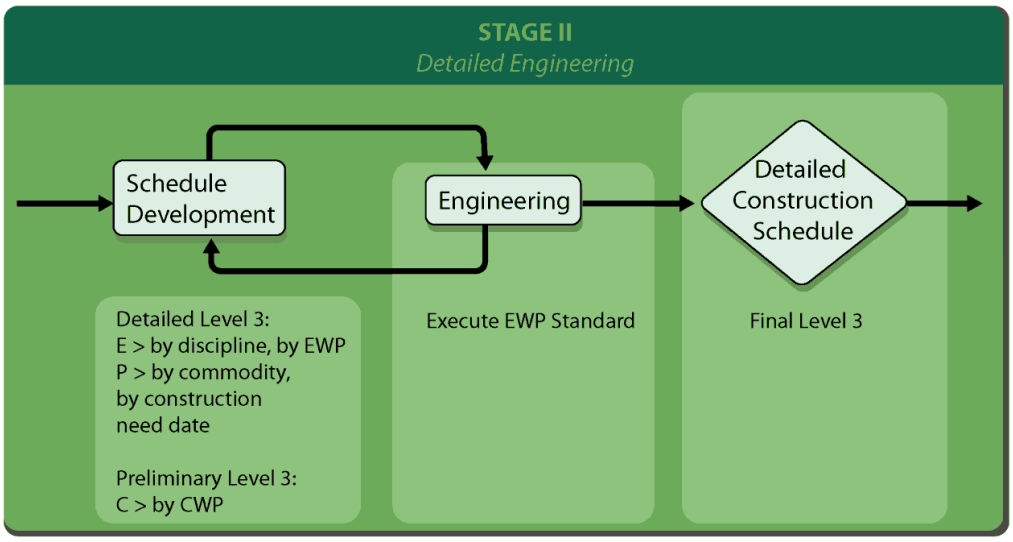


Figure 27 Stage 2 Flowchart - Detailed Engineering (CII, 2011b)

Stage III: Construction

An excerpt from the Implementation resource IR 272-2 Volume I describing Stage 3, Construction, is presented below:

> Stage III is also supported by the most detailed breakout flowcharts that show a more detailed flowchart for five separate steps in the construction process of managing installation work packages. Each of these five steps has a separate sub flowchart with more detail. The five steps include IWP creation, document control, issuance to the field, control in the field, and finally, IWP close out. Collectively these five steps represent a robust process for managing installation work packages. These processes document and extend leading practice as observed in CII member companies and COAA companies. The IWP management process described in stage III is also compatible with the lean construction practices for managing constraints. It is possible for a company to begin the implementation by focusing solely on IWPs; several case studies demonstrate that companies have chosen first to focus on the field before extending planning into project definition and engineering. Note that this is a viable although not recommended approach as projects that do not give adequate preplanning will face constraints on field planning in terms of engineering support.

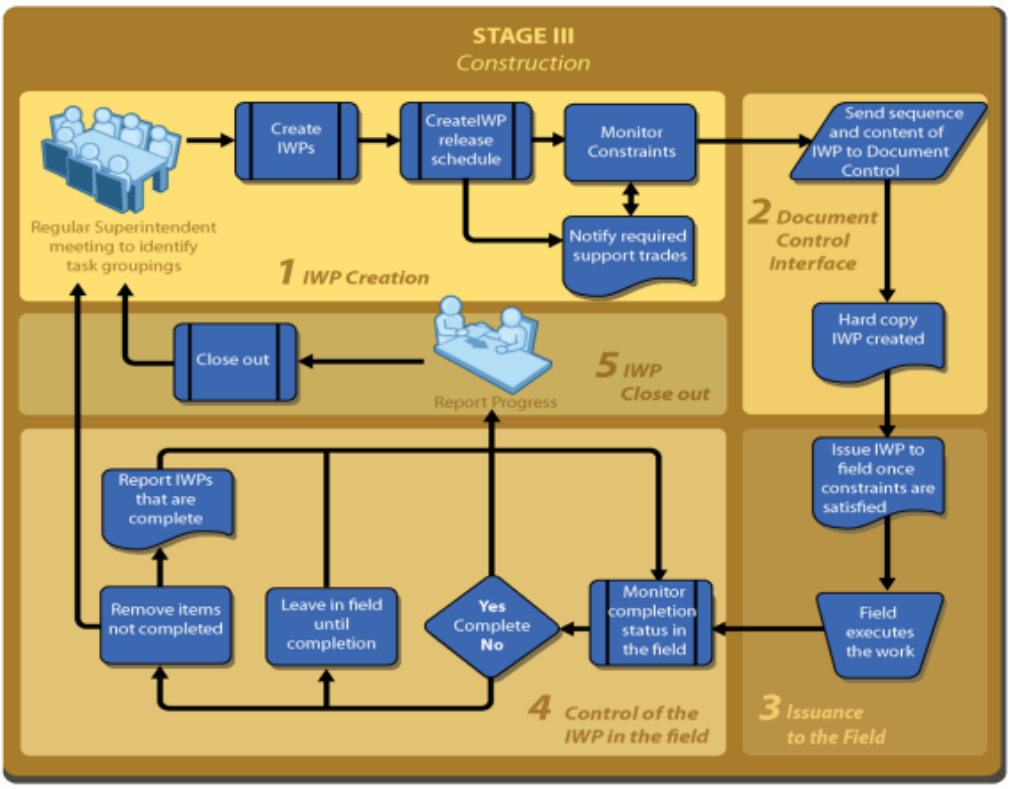


Figure 28 Flowchart - Construction (CII, 2011b)

4.2.2. LEVEL 2 FLOWCHART: SWIMLANES BY STAGE / PROJECT INTEGRATION FLOWCHART

Each of the stages presented in the execution model presented in Figure 20 is detailed into a group of project integration flowcharts that are available in Appendix E of IR 272-2 volume II. Figures 24 is a snapshots of one of the Swimlanes that are meant to meticulously show the detail of AWP implementation by stage.

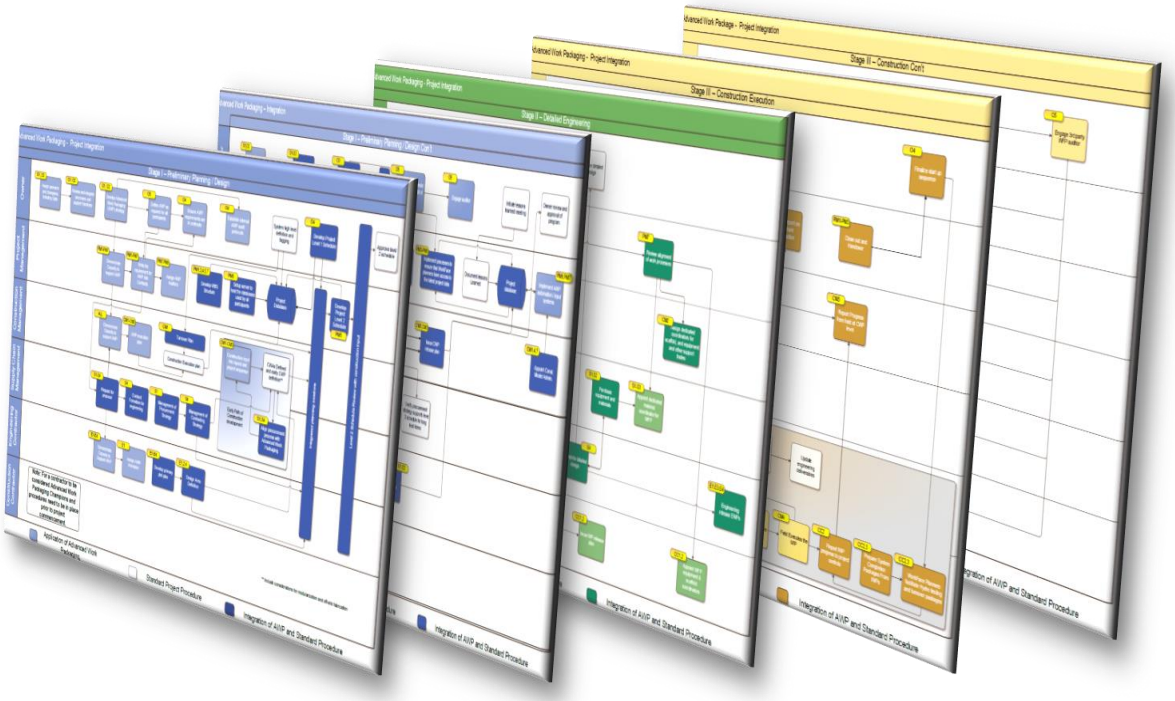


Figure 29 Snapshot of AWP swimlanes

The team developed a detailed narrative of the swim lanes that is presented in its implementation resource. They are also presented in a form of interactive pdfs that are available on the Construction Owners Association of Alberta (Here). Those interactive swimlanes contain not only process functions but also functional descriptions attached to each step. Those functional descriptions are detailed in Chapter 5 of this research report.

The project Integration flowchart narrative details for each stage and for each main functional side the role and strategy of implementation. For instance, during stage 1, the owner side is described through the following main points:

A. The Role of the Owner Organization
B. AWP Owner's Sponsor and Program Definition
C. Owner's AWP Strategy
D. AWP Program Audits by Owner

E. Owners AWP Packaging Procedures

The following excerpts from the Implementation Resource show examples of how is the detail of each one of the five elements concerning the owner. We will not include all the narratives in this research report. The reader can access it through the team implementation resource (IR 272-2 volume II 2013):

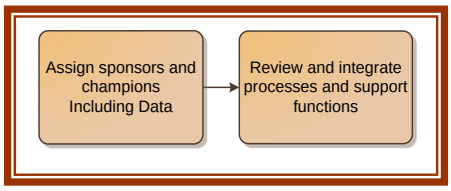
NB: Orange boxes presented below are snapshots extracted from the AWP integrated swimlanes as presented in the IR narrative.

1. The Role of the Owner Organization

"The Owner organization plays a significant role and often is the driver in the success of the AWP program for their projects. In the current market and labor scenario, improvement in productivity, cost certainty and drive up efficiencies; AWP brings in a methodology that introduces changes to the conventional approach of executing projects. Although, AWP essentially emphasizes early planning, packaging all the way back in to the design development process and to keep the discipline in the deliverables including hold points before rushing out, mobilizing crews and start work activities, the process demands commitment at the executive levels, some new people in the organization, modification to existing roles, organizing the deliverables as packages, inter-discipline and cross function coordination. It also pulls across many entities such as Owners internal organization, one or multiple Engineering & Procurement companies, the construction contractors and vendors. The Owner entity has the maximum stroke amongst these participants. A well thought out, timely introduction and adoption of the AWP program from an Owner entity has the potential to influence the success of the AWP on a project significantly than any other entity." (IR 272-2 volume II 2013)

2. AWP Owner's Sponsor and Program Definition

"AWP Owner's Sponsor and Program Definition



Owner's Sponsors

The AWP process demands that owners first identify sponsors and champions to ensure business objectives are understood, resources are committed, and leaders are supported and empowered to enforce decisions related to Advanced Work Packaging across all project stakeholders, beyond the owner‘s construction group.

Owner’s sponsor typically are:

- Vice President of Projects
- Project Director

The champions supporting the program are from the key stakeholder disciplines and as a minimum requires representation from the following for the success of the program:

- Engineering
- Supply Chain Management
- Construction
- Project Controls

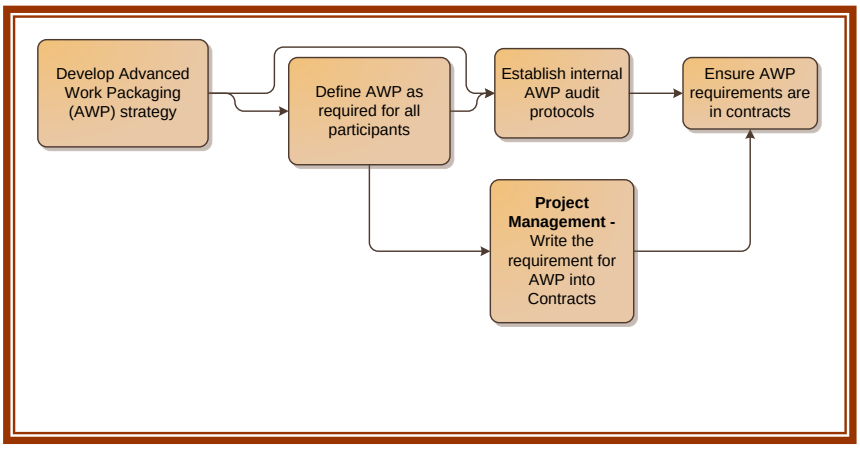
In addition to the above, naming an overall AWP champion who undertakes the implementation of the AWP Program charter as set for the project and includes integration of AWP data requirements. The Owner should also identify key staff from each functional group in the organization to support the implementation AWP Program. These may include: Project Controls, Engineering, Supply Chain, Computer Integrated Engineering and Construction. Collectively these individuals support the commitment and alignment necessary to institute and execute AWP requirements within the Owner organization and ensure that AWP requirements are being adhered to within their functions. The role of supply chain is critical also in terms that the program requirements make it across through contracts and other materials function to support AWP.

This team along with the overall AWP sponsor and all champions and key staff included in the overall project charter is essential for clarity and commitment to the program.

Business and Data Integration Aspects of AWP

Review of the Owner’s major processes and support functions should reveal integration requirements for AWP success. Note that this CII resource already identifies AWP activities that require integration with existing project processes to assist with this review, denoted by the darker color." (IR 272-2 volume II 2013)

3. Owner’s AWP Strategy



"Owner's Strategy Document

The next sequence of activities for the Owner starts with the AWP strategy. The strategy serves as a reference when establishing AWP requirements and a guide for making decisions during planning and execution of the project work. The AWP strategy should consider the Owner's organizational values and core capabilities, reflect the project's objectives, and appropriately weigh any unique project challenges such as geographic location or labor availability. This includes consideration of strategies identified by the Construction Management team, such as modularization.

All strategic principles should be ranked by importance, and should be directly matched to an AWP business objective, such as reduction of rework, higher quality, safety, greater field productivity or cost certainty.

The Owner's strategy document should declare the purpose and business objectives that AWP methodology has been brought on board for. It should also be clearly communicated the organizational commitment behind this by identifying the Program Sponsors and champions in charge of executing this in the document.

Owner's Procedure for the AWP Program

With strategy in hand, the Owner should devote significant effort to develop and issue detailed AWP requirements for all stakeholders, including definitions and standards for compliance. Definitions and standards should provide sufficient detail for owner Project Management to include concise contractual statements that commit all parties to AWP requirements, and enable the owner to track compliance.

In a similar way the Owner should also include sections where they declare internal and external (revisit 'internal' in flow chart) audit protocols based on the requirements to measure compliance within the organization and project

participants. The audits should include measurable criteria – see appendix (Ref the audit checklist)

Besides the point in time audits, a continuous process of 'In process verification' (IPV) can also be applied to the program. IPV is the process of checking a product, service or system meets specifications. Through IPV, a high degree of assurance is created that a product, service or system fulfills its intended purpose.

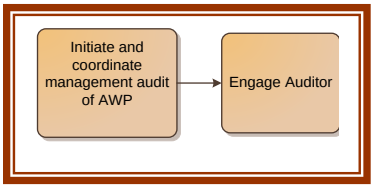
The mandate for the In Process Verification is to ensure that the AWP and WorkFace Planning methods are applied to meet the intent of the program by the participating companies throughout all phases of the project starting from EDS, detail engineering to field and module construction works.

The disciplined use of IPV in WorkFace Planning is to ensure effective transfer of package custody to the Owner's commissioning group occurs with minimal delays.

As an example, during construction, IPV will focus on the following from the Construction Contractor:

- Reporting progress bi-weekly
- Input progress into the model
- Construction complete
- Testing complete
- Reinstate " (IR 272-2 volume II 2013)

4. AWP Program Audits by Owner

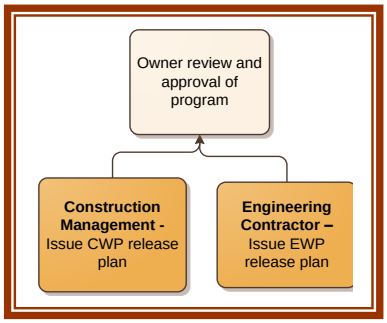


"Audits that are planned, structured and conducted at predetermined points of time can assist in identifying the level of adoption and success with the program. However, it should be in complement to the weekly management functions of status tracking deliverables and their progress by EWPs, CWPs or IWPs, the organizations issues, Management of Change process and keeping a pulse of the job for AWP.

Formal Audits or in-house assessments, either or both methods can be employed to ensure the AWP program is on track.

The CII-COAA Project Definition Assessment tool can be used as a template during the initial stages of implementing AWP." (IR 272-2 volume II 2013)

5. Owners AWP Packaging Procedures



"The Owner should review the issued AWP plans from Construction Management and Engineering prior to approval of the overall project AWP plan. This may require iterative development of CWP and EWP plans, which should be executed via a formal management of change process inclusive of all stakeholders." (IR 272-2 volume II 2013)

The reader can find the complete detail of each of the boxes in section 3 of the implementation resource IR 272-2 volume II. The section describes not only the Swimlanes and how they can be used but also gives insight about indirect costs and keys for successful implementation. Additionally, the section contains a narrative generated by an Owner currently implementing AWP across the project lifecycle.

4.3. IMPLEMENTATION TOOLS AND SUPPORTING TEMPLATES

The team developed a set of implementation tools through the two phases of the project. The first phase gave birth to three main tools: Project Definition Assessment Tool, Assurance/Audit Tool, and work packaging Scorecard. Through the second phase, the team improved those tools and added others to come up with a final set of tools that are meant to facilitate Advanced Work Packaging at any stage: through early implementation or advanced implementation. Those tools are included in the appendices of this report and are listed below:

- → AWP Maturity Model
- → Contractor Qualification Assessment
- → Project Definition Assessment Tool
- → AWP Audit Tool by Phase
- → AWP Project Integration Flowcharts
- → AWP Functional Role Descriptions
- → CWP Template
- → EWP Template
- → IWP Checklists by Discipline

Each of those tools are detailed in the team two implementation resources: IR 272-2 volume I and II. In this chapter, only process related tools are presented below. For instance, the contractor qualification selection tool will be presented in chapter 5 which is the contracts chapter; the functional role descriptions will be detailed in chapter 6. Below are excerpts, taken from the team implementation resources, about the purpose and usefulness of a selected number of those tools.

AWP Maturity Model

The question of how companies with different levels of maturity and different processes and resources can apply Advanced Work Packaging was raised within the team. Expert

interviews also brought to the table a concern from experts across North America about the "feasibility" of Advanced Work Packaging implementation. During the first stages of the research work, the team decided to postpone working on a maturity assessment as it decided that it is more appropriate to develop and finish the Advanced Work Packaging process details and narratives prior to developing and assessment tool. The team defines the industry need to a maturity assessment as follows:

> While organizations must make independent and specific assessments of Advanced Work Packaging, it was not deemed helpful to stop there without providing some specific guidance that explicitly recognizes organizations' different starting points. This need motivated RT 272's development of an AWP / WFP maturity assessment model. It is the goal of a maturity model to define concrete steps by which an organization progresses in its capabilities. The maturity model accomplishes this by defining common states within the industry. An organization can map its current capabilities to these common states. The maturity model provides a foundation for assessment of current capabilities as well as indicating discreet steps by which an organization may advance.

The Maturity Model as defined by the team is a: "a qualitative description of capabilities is intuitively appealing to many." Its purpose is to:

> [The Maturity Model is used to] assess an organization's AWP / WFP integration status at three levels and across multiple functions that support capital project execution. While variations in practice are large both within and across companies, each of the three levels of the Maturity Model is meant to capture a state that is broadly identifiable and applicable to COAA and CII member companies. Each level describes both work processes as well as accompanying project systems. Each level builds from the capabilities of the previous level and as such, companies are expected to progress up each level in a stepwise fashion.

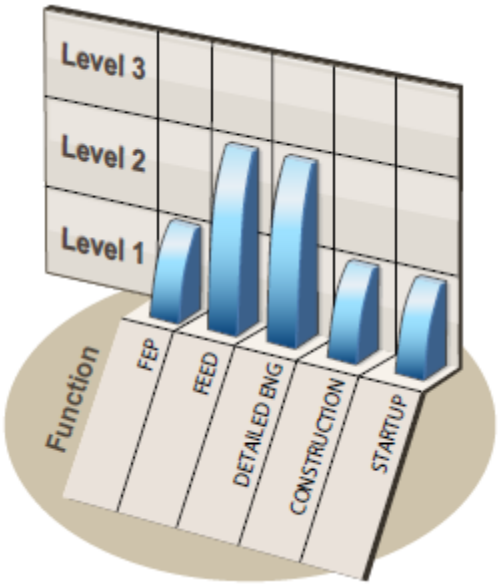


Figure 30 Example of an organization maturity assessment across multiple phases of a project

As illustrated by figure 26, it is composed of three main levels detailed in two tables (see appendix XX) those levels are:

Level 1: AWP Business Efficiency

Level 2: AWP Business Effectiveness

Level 3: AWP Business Transformation

The maturity model plays the role of a first step into the move toward Advanced Work Packaging. The team provides three main steps based on the use of the maturity model: Assessment, Gap Analysis and Portfolio Development. The following extracts from the Implementation Resource IT 373-2 Volume II explain those three steps:

Assessment

The goal of the assessment process is to develop a shared understanding of current corporate AWP / WFP integration status. Assessment should be performed by a team with detailed knowledge of work processes and capabilities. Such a team may be complemented by 3rd party experts (consultants), but it is recommended that the team be led by those responsible for business stages. The assessment process is an opportunity for organizational alignment and education around AWP / WFP integration capabilities and thus broad involvement can be beneficial. The maturity model can support productive discussion in hour-long meetings.

The first goal – shared understanding – is performed with the maturity model which has the best description of the three levels across broad dimensions. The team performing assessment should calibrate their understanding of the maturity model to ensure each member has a common understanding of each level. Initial meetings may focus on the team using the model to generate a description of levels using organization names, standards, and examples. This will both help calibration within the team as well as help translation and education to the broader audience within the organization.

Gap Analysis

Building from assessment, the next step is to develop a gap analysis for key capabilities across the organization. An important contribution of the maturity model is to force organizations to look holistically at their AWP / WFP integration capabilities across the phases. The example in Figure 1 of an organization largely at level one is intentional. It is possible that the organization might be very accomplished in its two level two functions (FEED, Detailed Engineering), but have level one capabilities in its other functions. It is possible that the level 2 capabilities are more visible to management and may give the (false) impression that the organization is performing at level 2 generally. The maturity model forces a broad examination across the main capital project business functions and helps ensure gaps identified and resulting plans are well considered.

Portfolio Development

Once gaps have been identified the next step is to develop a portfolio of specific AWP / WFP opportunities. These opportunities should detail specific concepts that can be developed and deployed. They are a necessary link between an identified area for improvement and an action plan. It is likely that as part of assessment and gap analysis, the organization will generate many ideas for new work process capabilities – likely too many to implement at once. The portfolio is meant to be a place to record these ideas so they are not lost and also as a place where they can start to be ranked in a systematic manner.

Contractor Qualification Assessment

Refer to Chapter 5

Certain assessment tools have been developed by both COAA and CII, including the AWP Project Definition Assessment Tool, the AWP Contractor Pre-Qualification Assessment, and the AWP Audit Tool by Phase (aka the AWP Scorecard). The team recommends those tools to be tailored to the stage of the project lifecycle, its characteristics and the company specific procedures.

Project Definition Assessment Tool

An excerpt from the Implementation Resource IR 272-2 Volume II describing the Project Definition Assessment tool is presented below:

> An AWP Project Definition Assessment Tool is provided to help project teams assess readiness before starting AWP implementation on a specific project. The tool is divided into different organizations/functional roles: Owner, Project Management, Construction Management, Engineering Contractor, Supply Chain Management, and Construction Contractor. […] The AWP Audit Tool by Phase is complementary with the Project Definition Tool; effective project definition activities should lead to improved performance that will be shown during audits.

The tool is available in Appendix C of IR272-2 volume II.

AWP Audit Tool by Phase

This tool is also an assessment tool. An excerpt from the Implementation Resource IR 272-2 Volume II, Implementation AWP audit tool: Definition Assessment tool is presented below:

> The AWP Audit tool is meant to assess conformity to the AWP processes at each stage of the project. It is primarily for use by the Owner but can also be used by other parties to identify gaps in AWP implementation. Suggested assessment timings are included as steps in the AWP Project Integration.

This tool is available in Appendix D of IR272-2 volume II.

AWP Project Integration Flowcharts

Detailed above (see chapter 4 section 4.2)

AWP Functional Role Descriptions

Refer to Chapter 5

EWP Templates

The research team has come up with templates that are ready to use for Engineering Work Packages formation. Those templates are available in the Implementation Resource IR

272-2 Volume II appendices and a description of them exist in section 4: Templates and Checklists. Below is an excerpt from this section about the use of the EWP template:

> Use this template as a basis for creation and reference for all information applicable to a EWP. The template is provided in Appendix H. As for CWPs, the template is designed to accommodate varying amounts of information detail or formatting. EWP information formats range from basic narrative text to itemized lists in point form to references or embedded diagrams. Organizations should develop and share consistent practices regarding detail and style to meet the requirements of clients, contracting parties or other stakeholders. The EWP template includes 13 sections. Sections are organized to reflect the most commonly accessed information in sequence, but provides contact information at the end for quick reference.
>
> […] A typical EWP for a CWP includes the following:
> - scope of work with document list
> - drawings (e.g., general arrangement and equipment installation)
> - installation and materials specifications
> - vendor data (e.g., equipment O&M manuals)
> - bill of materials
> - lists (e.g., line lists and equipment lists)
> - additional pertinent information to support (e.g., permitting studies).

CWP template

The research team has come up with templates that are ready to use for Construction Work Packages formation. Those templates are available in the Implementation Resource IR 272-2 Volume II appendices and a description of them exist in section 4: Templates and Checklists. Below is an excerpt from this section about the use of the EWP template:

> Use this template as a basis for creation and reference for all information applicable to a Construction Work Package (CWP). The template is provided in Appendix G. The template is designed to accommodate varying amounts of information detail or formatting. CWP information formats range from basic narrative text to itemized lists in point form to references or embedded diagrams. Organizations should develop and share consistent practices regarding detail and style to meet the requirements of clients, contracting parties or other stakeholders. The CWP template includes 21 sections. Sections are organized to reflect the most commonly accessed information in sequence, but provides contact information at the end for quick reference.
>
> […]CWP is typically aligned with a bid package. A typical CWP includes the following:
> - safety requirements
> - at least one EWP
> - schedule

- budget (labor hours/cost/productivity)
- environmental requirements
- quality requirements
- special resource requirements.

IWP Checklists by Discipline

The research team has come up with a number of checklists that can be used by companies to enhance their work packaging processes. Those checklists are available in the Implementation Resource IR 272-2 Volume II appendices and a description of them exist in section 4: Templates and Checklists. This tool was developed by COAA and was deemed useful by RT 272 (COAA, 2007). Below is an excerpt from this section about the use of the EWP template:

> IWP checklists are meant to be reviewed and approved by the appropriate supervisory and WorkFace planning personnel (i.e., planner, superintendent, HSE, quality, and foreman). This review should ensure that all the necessary requirements and constraints for each discipline IWP have been met. The approvals for the discipline-specific checklists should be documented at least one week prior to the commencement of the IWP, so that, if necessary, there is adequate time to substitute another IWP that has met all of its requirements and constraints.

4.4. AWP PROCESS IN NORTH AMERICAN CONSTRUCTION INDUSTRY: FINDINGS FROM EXPERT INTERVIEWS

One of the biggest findings of the interviews is the documentation of a wide range of practices related to work packaging, which shows that the construction industry in North America, although aware of the terminology, contains different perceptions and definitions of the same terms. This variety in work packaging practices can be depicted within the framework of processes through the examination of the following items:

- Work packaging hierarchy and definitions
- The formation process of work packages
- The content of work packages

Other aspects of work packaging like the cultural side of the implementation, the contractual side or the organization side are detailed in Chapters 5 and 6 where the focus is on the organizational and contractual aspects of work packaging. Within the context of this chapter, the findings are presented to support the process aspect of Advanced Work Packaging.

4.4.1. WORK PACKAGING HIERARCHY AND DEFINITIONS

4.4.1.1. Definition of work packaging

Work packaging is the process of breaking down work into manageable pieces. This definition has been agreed on by the majority of the interviewed people. The differences reside in the level of formality of work packaging as well as the level of implementation of work packaging practices within the company. As far as the level of formality, our findings from the interviews related to the construction industry in North America show that the industry is divided between companies that developed or adopted formal processes for work packaging such as WorkFace planning and other companies that do not use formal work packaging processes but have in place other practices that can be understood in terms of work packaging. For instance, A which is an oil and gas EPC company has a formal process of work breakdown into workable packages that starts at the Front End Engineering Design phase. Company has a pre-defined set

of definitions of its various work packages. Company C, which is an owner in the power industry, has a three step formal work packaging process that contains a customized terminology articulated around the percentage of completed design.

The level of implementation varies also from one company to the other. For some companies, work packaging practices are implemented through the entire company projects, while for others, it is implemented to only one project or one geographical area.

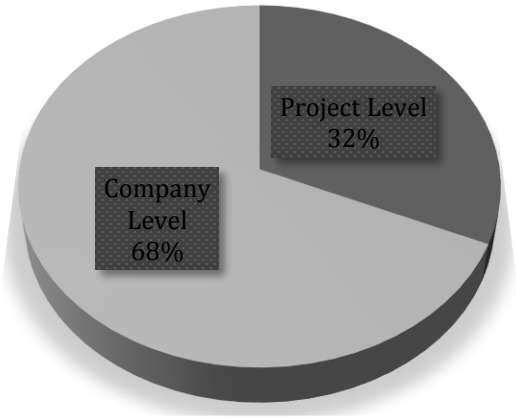


Figure 31 Expert interviews - AWP implementation level

Companies choose the level of implementation of work packaging practices based on several criteria. One of them is the strategic decision of "trying" the implementation of new practices on a particular project before generalizing to other projects. Usually, those projects are pilot projects for work packaging. Other reasons include projects specific characteristics. In this case, the need to a formal process to monitor the project induces the implementation of a formal work packaging strategy on the project. Company D, which is an industrial EPC company, used this approach on a project as reported by expert 4, a project manager at the company. In fact, the project was a combination of renovation and green field work based on a lump sum basis and which lasts about three years and a half. The contractual structure of the project included an overlap in time of both a revamp portion and a green field portion of the job. At 25%

construction completed, the company decided to implement a specific work packaging system customized to the project characteristics aiming to support the contracting schedule. Expert 4 said that this project is very probably the most complex project he has seen during his 40-year career. He also mentions that, without the use of a formal project level implementation of work packaging, this project would not be properly done. In addition to being the project manager, expert 4 was the pioneer for the work packaging implementation of this project. No special training was done for implementation purpose. Guiding documents about work packaging were provided to discipline leads. The example of company D is an illustration of how implementation may vary because of the project conditions and implied needs.

4.4.1.2. Breakdown structures: CWP, EWP, PWP and IWP

Based on expert interviews and case studies, it is commonly known and agreed upon that breaking down work into manageable pieces is a process that depends on the project. Criteria for breaking down work and packaging it are mainly based on geographical area, discipline and then sub-system or time. For instance, company A breaks any project automatically to Construction Work Areas (CWA) that are then divided into Construction Work Packages which are discipline based. As shown in Figure 32 Construction Work packages are divided into CWPs for major disciplines and other for minor disciplines. In the construction section of the WBS, CWP breakdown is consistent with the WBS. WBS for engineering and procurement can be different from the work packaging scale. For this case, Engineering Work Packages play the role of input as they are only drawings re-requested based on the breakdown of CWPs.

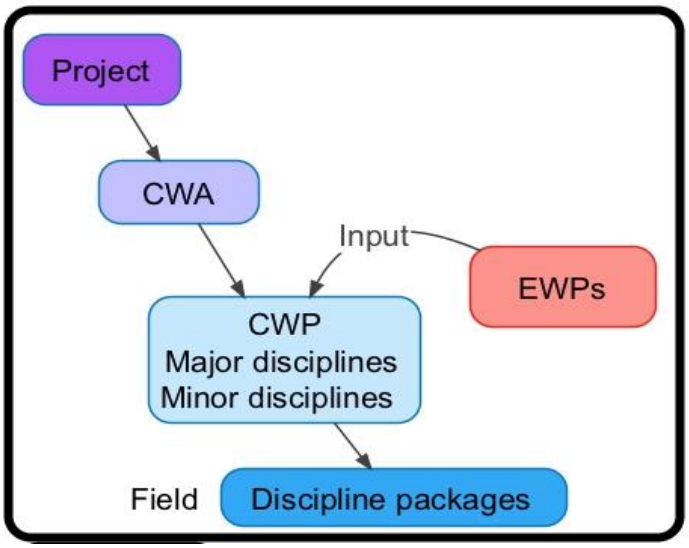


Figure 32 Work Packaging Breakdown for Company A

Company D has a similar approach that is common to the majority of studied companies especially in using the geographical area breakdown approach (see Figure 33). However, because of the project contracting characteristic of being sensitive to both time and space, company D added another level of breakdown based on the project phase. As shown in Figure 34, the organization of the project impacted the work packaging structure.

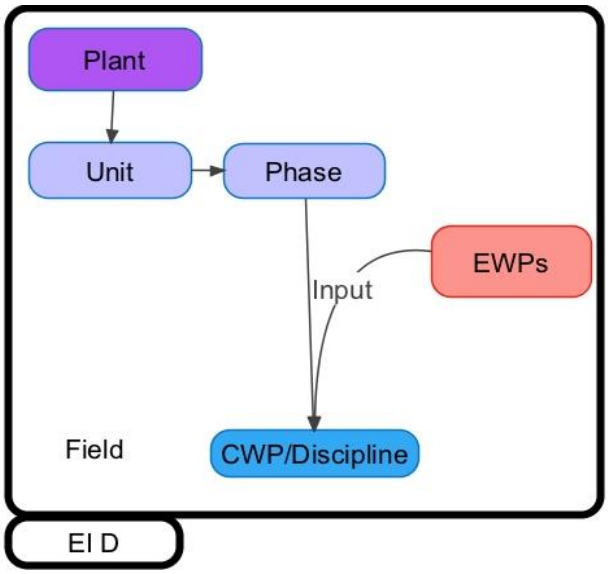


Figure 33 Work Packaging Breakdown for Company D

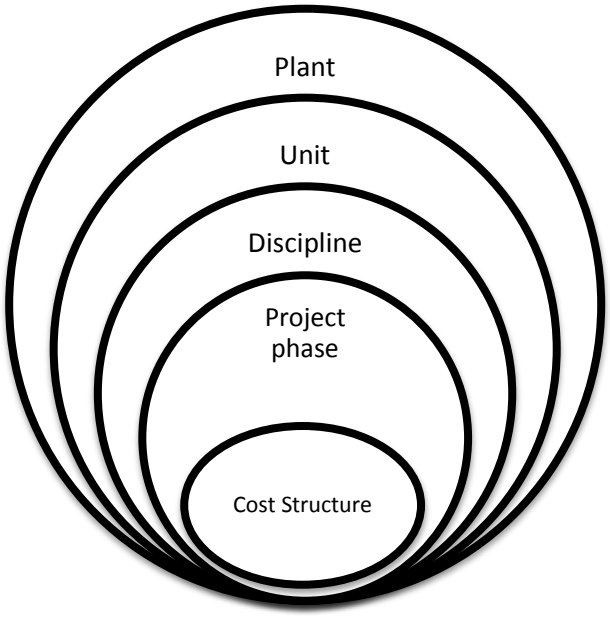


Figure 34 Project phase impact on work packaging structure (example of company D)

Company D has also another work packaging structure implemented on projects in the Alberta region (Canada). Within this area, the work packaging method implemented is WorkFace planning. The terminology used is based on the COAA practice model. WFP breakdown that is also used by company E and C are presented in figures 34 and 35. The cost

breakdown is in few examples directly linked to the work packaging structure. For instance, company C bases its project breakdown on the cost structure. In fact, during the first stage of front end phase (the 30% stage design), the main objective is to develop an initial Construction Work Packaging Plan within the Design Input Record (DIR). The DIR is a sort of a conceptual walk down which provides input to the Engineering work Packages (EWPs). The Design Input Record (DIR), which is basically a design box, contains typically the specifications and regulations, the margins and the design parameters. The Design Input Records are mainly divided by cost. The smallest DIR is about $1000.

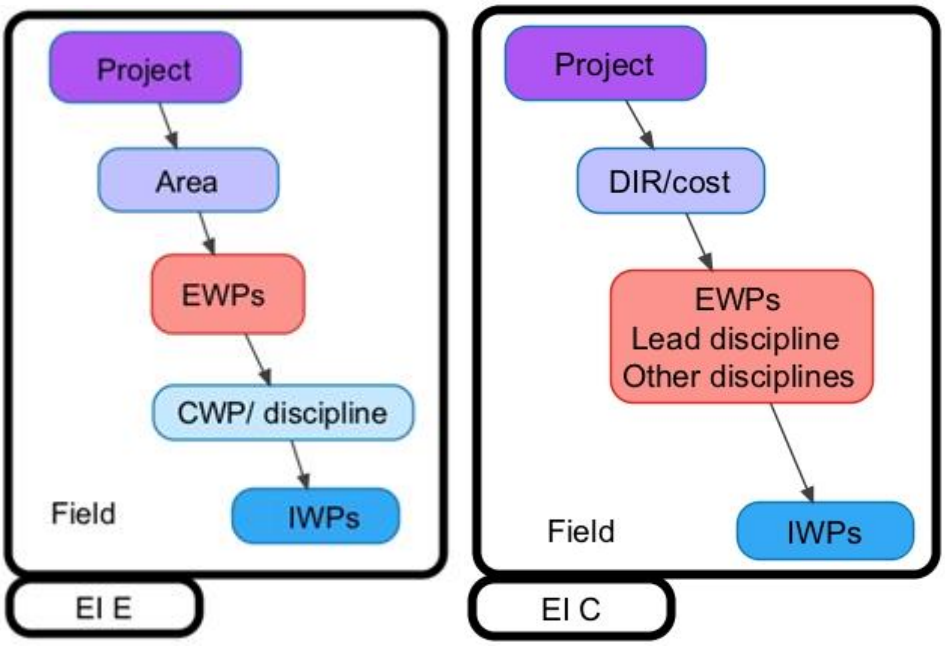


Figure 35 Work Packaging Breakdown for Company E

Figure 36 Work Packaging Breakdown for Company C

While criteria like geographical area or discipline are very common, there is a difference in the level of detail related to each of those criteria. For instance, as shown in figures 34 and 35,

companies can add a level of detail to the work packaging process or delete/ skip a level of detail because of the projects characteristics.

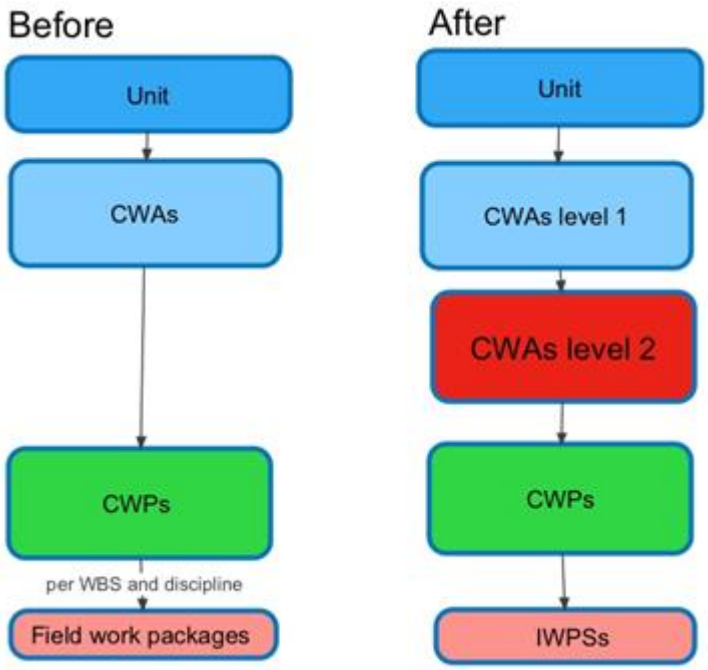


Figure 37 Customized Work Packaging Structure D

Within company D, previously, Construction Work Areas (CWAs) are divided into CWPs that are each about 10,000 labor hours (can go to 20,000 or 30,000 = several weeks of work). These CWPs include schedule and budget and per WBS, they were divided by prime discipline to get issued to the field crews. When WFP was introduced, the work was still divided by area but a second level of breakout was added. In fact, sub-areas were defined and packages for sub-areas contained: budget, schedule, quality and specifications. The process was designed to make sure no interfaces were existing between packages as well as reliable and interfaces free scaffolding planning.

Company J opted for deleting a step in the breakdown structure of WorkFace planning. Company J has adopted the WorkFace Planning per COAA definition and has shaped it to the company characteristics. The main difference in the WFP model use within Company J is that

they skipped the Construction Work Packages (CWPs). Expert 13 said that "within the company, they have learnt that developing CWP per COAA model is a waste of time and energy and that getting directly for IWPs is more efficient". CWPs were found to add to the timeline even though the scope of work is already known. This induced duplicated efforts in both CWPs and IWPs.

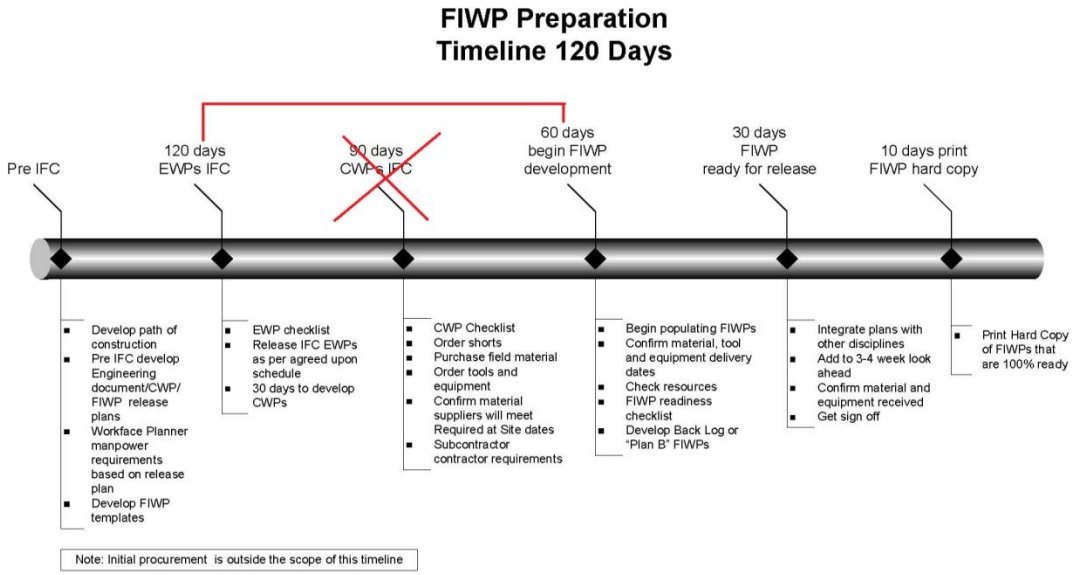


Figure 38 IWP preparation per COAA model as modified by Company J

It is important to mention that those decisions regarding the level of detail and level of implementation of work packaging practices are shaped by the context of their application. The context is dictated by the company size, the project size and other specific characteristics of the project. Expert 8 who is a consultant for WorkFace Planning and Advanced Work Packaging emphasizes on the importance of the process of customizing work packaging to the company.

Construction Work Packages (CWP): are discipline based. Expert 17 mentions that EWP and CWPs are the same for company E. The breaking down process of projects into CWPs is based on two criteria: the size that should be manageable and most importantly the logic of work execution. As shown in figure XX, the WorkFace planning structure was not followed literally

but was customized to the project. In this specific case, EWP and CWP played the same role and designated the same type of package.

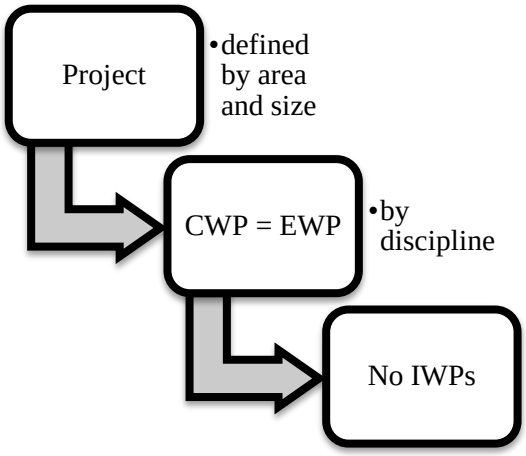


Figure 39 WFP modified - Example of IWP deleted Company E / Expert 17

Expert 8, who has been a productivity specialist for more than 10 years, thinks that a Construction Work Package is a translation of an Engineering Work Package to the construction phase. Both are area based and are defined after Construction Work Areas specified. From interviews with several companies, this is perceived as the main guideline for the breakdown procedure of the project into work packages.

Other breakdown criteria might include also the contracting strategy, systems in place and modularization. For instance, within company E, the scope of a CWP remains large and multi-disciplined. For company E, there is no typical size for CWPs and those are developed mainly based on the owner efforts and then the review of the engineering and procurement houses. Expert 7 from company E mentions that if procurement people or construction people decide that an existing CWP is not feasible, this CWP is then broken down to smaller CWPs.

4.4.2. THE FORMATION PROCESS OF WORK PACKAGES

4.4.2.1. Development and Issuance of work packages: examples

Issuance of CWPs:

Based on the several interviews, the process of elaborating CWPs and issuing them is more or less formal. One of the most important observations that one can make is related to the correlation that exists between the formality of the work packaging structure and the formality of the development and issuance processes. Company D is for instance the example of one of the most Advanced Work Packaging systems in developing its Construction Work Packages. Within Company D, each discipline provides two types of input in the CWP Management system to generate a CWP: the originator's form and the discipline drawings. The originator's form containing the work characteristics, the unit number, the document type and the phase. The Project Document and Data Management (PDDM) people then upload this form to the company Provisioning Object Library (POL). The CWP management system administrator exports then the form from the POL to the CWP Management system. The CWP manager uploads also the discipline drawings in the CWP management system that generates finally a CWP Documents List reviewed and edited by each Discipline (Material check is done by each discipline). Finally, the construction/field PDDM prints CWP documents and issue to the contractor a complete CWP containing specific deliverables and narratives related to the discipline.

Issuance of EWPs:

According to expert 1, a workable engineering package is a package with parameters defined by the construction side on how to get work done. It does contain engineering drawings by discipline. The issuance of EWPs involves more than any other type of packages the contracting strategy and the contracting process. For instance, interviews have showed that EWPs are critical for the bidding process. For instance, for expert 7, as there is no typical size for EWPs, the criterion for an EWP to be validated is: whether or not this package can be completed within the time frame to be sent out for bid.

Issuance of PWPs:

A Procurement Work Package (PWP) is not a common package in industry practice. As far as our range of interviewed companies, very few are those who specifically identified procurement work packages as formal packages within their companies. However, a lot of the

interviewees emphasize on the criticality of incorporating procurement in the formation process. This can be done through involving procurement people or considering procurement schedule and milestones in the packages breakdown similarly as considering the construction sequence. Expert 18 is a system and integration manager in company M. She is directly involved with the procurement management of oil and gas projects within company M and describes the development of a procurement Work package (PWP) as follows: First, the engineering side identifies all EWPs of the project. Key procurement milestones are then developed in collaboration with engineering. Then follows the development of a PWP release plan which is done by the procurement team in collaboration with the engineering team. Once a list of PWP is almost complete, each PWP completed is tracked regarding three main info: 1) the baseline date, 2) the expected date and 3) the actual date. This process is a collective effort between procurement team, engineering team and materials management team. Expert 18 said that with few exceptions, the current PWP release plan is consistent with the actual plan.

Issuance of IWPs:

IWPs are also called IWPs by companies that use the COAA WorkFace planning model previously presented in the beginning of chapter 4. IWPs or IWPs are prepared for the construction phase and are issued for people in the construction site to guide their work execution. However, the preparation of IWPs go beyond the construction phase and involves the FEED phase in a lot of cases. For instance, expert 8 mentions that the basic outline of IWPs is developed in the engineering office by WFP planners and other knowledgeable people. EWP are developed at the latest 3 weeks before the actual work. After that, WorkFace planners get those packages and translates them IWPs. The preparation follows those general steps:

- 1st week: EWPs cut into IWPs
- 2nd week: constraint identification and elimination
- 3rd week: IWP scheduling

An example of all those packages ties together is the how work packaging is articulated around the bidding process. The bidding process within company E is described by expert 7 as

follows: the process contains 3 parts: the scoping & Study, the DBM: Design Basis Memorandum and the EDS: Engineering, design, Specification. After bidding, the IFB (Issue For Bid) is issued and the owner asks the contractor for budget and schedule. Once the contractor awarded, the owner works with the General Contractor to complete CWPs. The final input are EWP, IFC, regulatory requirements, and materials. A complete CWP will be issued for construction not for biding. Once the contract engaged, IFC and CWPs are developed. Then, IWP release plan is required from each contractor. The owner makes sure that there are enough engineers to create a backlog and that engineering is making progress to be able to continue.

Finally, Project Controls play an important role in the formation process of work packages. For instance, company H bases its work packages breakdown on cost estimates which allow refining of work packages after evaluation. Figure 40 shows this process.

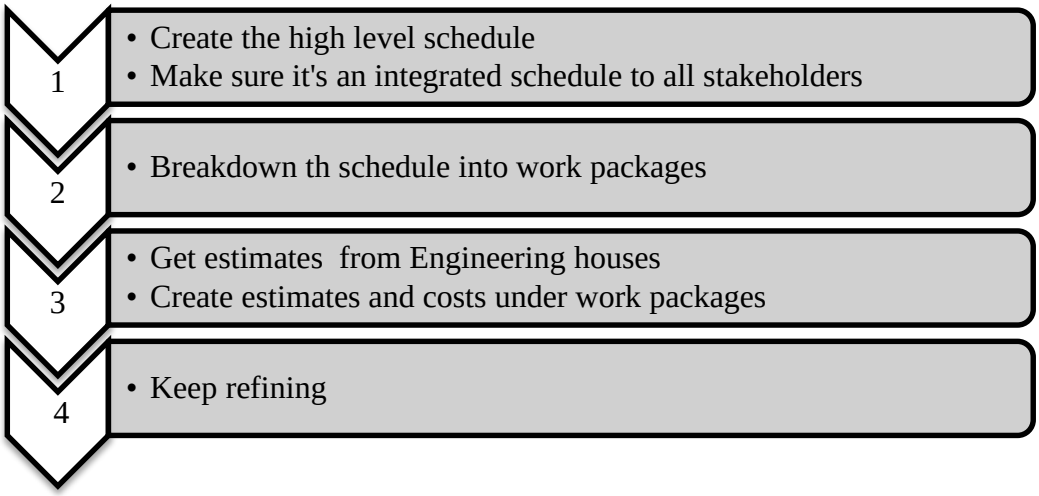


Figure 40 Work packaging process - Example of company H

4.4.2.2. Tracking of work packages / Updating

Almost all interviewees mentioned that tracking work packages is very critical to the success of the work packaging processes. However, not all of them had within their respective companies the same practices as to track in formation work packages or issued work packages. The following section shows examples of tracking practices collected through the interviews

conducted during the research phase. Those practices include the updating process which is a form of tracking. For example, as far as CWPs are concerned, a CWP is revised when new documents are added or when documents are deleted. For company D, some CWPs are revised up to 7 times. The updating process made through the document control system in which is monitored every document in different CWPs. Figure 41 shows the revision steps of a CWP.

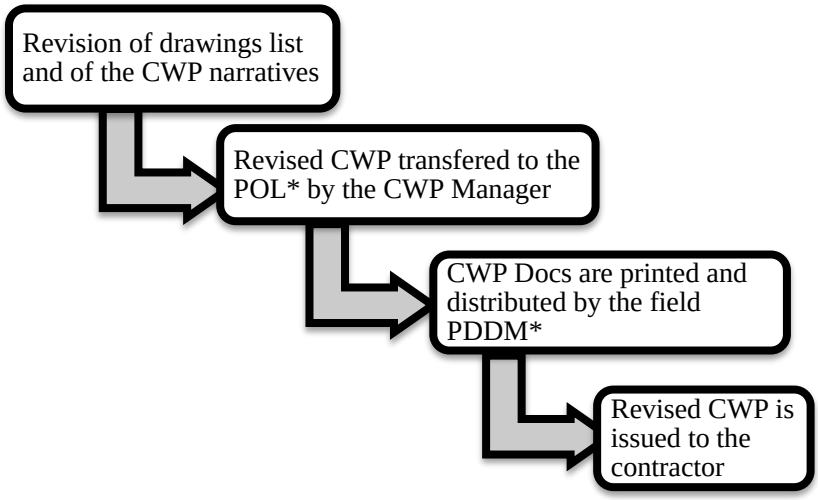


FIGURE 41 CWP REVISION PROCESS - EXAMPLE OF COMPANY D

*Field PDDM: Project Document and Data Management

Company C has a work packaging management system that is tracking the list of all activities on a weekly basis. There are also different types of meetings and reviewing processes to track the project progress status: weekly schedule review meetings focused on the engineering work, weekly schedule accountability meetings and monthly float assessment based on updated schedules after meetings. The main tool used is Primavera, which can generate reports. Expert 3 from company C thinks that the company is making a maximum use of the software and that the software is very suited to the work packaging process. MS Project was not chosen because it lacks of functionalities to control cost for big organizational capacities exceeding $1.5 Million.

As far as engineering work packages, company E presents its way of tracking engineering work in general. Indeed, this is done using engineering and project productivity curves. These

curves show how engineers are going to perform which helps assess more accurately reasonable and suitable speed of work and schedule. The way this is monitored is based on a regular reporting required by company E (owner) for each engineering stakeholder (internal or external); a report from data to see where are CWPs and EWPs; use indicators and cross functional analysis. Company J has a more formal process of tracking all its work packages. The process is tightly correlated with the planning process. In fact, in expert 13 point of view and within company J terminology, there are two phases in the planning process: the static planning phase and the dynamic planning phase. The transition from static planning to dynamic planning happens as soon as IWPs are issued to field. The dynamic planning phase happens during the construction phase. Progress is measured by unit of measure and once a work package is completed, the package is closed. On the static side, the progress measurement is done according to the schedule. For each task, there is a start date and a deadline. For instance, a typical IWP takes 51 days to be prepared. This is a critical path (minimum). Every step during those 51 days is monitored.

Tracking on site is also very important to the project success. The example of company K shows the recourse to visual tools to track different packages. In the construction job site, company K has a visual space for CWPs and EWPs letting people on site track the availability of EWPs. The following figure shows the way this is organized on site. As soon as an EWP is complete, it is sent on site to feed the correspondent CWP. A CWP contains EWPs, material list, craft planning and construction equipment.

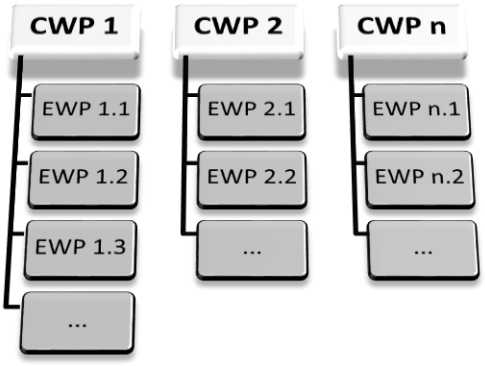


Figure 42 Work Packages tracking on site board - example of company K

Expert 8, an experienced consultant, believes tracking is a sensitive subject for engineering. When an engineering work package is developed, the number of drawings needed should be easily estimated. EWPs can be considered as performance indicators and can create then a source of conflict between owners and engineering.

4.4.3. THE CONTENT OF WORK PACKAGES

The following table shows the typical content of a CWP, EWP, PWP and IWP.

Table 4 Typical content of different work packages

CWP	EWP	PWP	IWP
- Scope of work - Engineering information - Manpower - Materials - Environmental, health & safety - Quality - Regulatory approvals and permits - Sub-contractors - Vendor support - Rigging studies - Scaffolding - Construction equipment, tools and consumables - Waste management - risk - WorkFace planning - Project controls - Turnover documents	- Drawings - Bills of materials - Scope of work description - Permit requirements - Design specifications - Vendor data - General impact plan - Separate documentation issued for needed support - Change evaluation	- Engineering requisition - Procurement milestone - Pre-quotes - Purchase Order issues - Shipment to site details	- Scope of work + checklists - Safety assessment documents - Bills of material - Shift work assignment - Surveys related to time lost or workforce issues - Drawings - Inspection documents - Vendor data

4.5. VALIDATION & DISCUSSION

Advanced Work Packaging is a process that involves many stakeholders and touches on the main components of a construction project from engineering to construction and procurement. This makes the structure and hierarchy as well as the dynamic of people involvement within the AWP execution model critical to its success in fostering the project

productivity and predictability. Expert V4 mentions that designing AWP, is in effect, establishing a process that will ensure information, equipment, and materials will FLOW to the jobsite in a timely manner to provide the craft person everything they need to do the work. While the value of the AWP execution model presented by RT 272 was highlighted by the validation interviews conducted, industry experts implementing AWP still face several challenges at different levels. Those challenges detailed in Chapter 7 as well as in the interviews write-up in the appendices are part of the equation. In fact, they are induced by the implementation environment as well as the construction industry history with integrated working environment. The main concern being that work packaging processes being perceived "very" construction driven, facilitating work for construction people and making it more difficult for engineering people to cope with the project needs under the traditional budgeting. This has been relatively addressed by the main argument of specifying that Advanced Work Packaging implementation is accompanied by a number of assumptions including the important role the owner needs to play to make it successful as well as the importance to address the contractual and organizational side of its implementation. Those two sides will be developed into further detail in the following chapters.

CHAPTER 5. ORGANIZATION AND FUNCTIONAL CAPABILITIES

Working on the organizational and functional capabilities as part of Advanced Work Packaging model was inevitable. Indeed, the question of responsibilities within the scope of the needed tasks for Advanced Work Packages was critical for the development of the implementation Resource. A second question was also critical to clarify the integration of AWP recommendations in the industry: how is AWP project integration process going to affect existing organizational and functional capabilities of companies? To answer those two questions, RT 272 has worked on developing, in conjunction with the AWP Project Integration Flowcharts (PIF), a set of thirty-two role descriptions that are presented subsequently.

The section also contains an overview of the main findings related to this aspect from both case studies and expert interviews. We will present this based on the following sub-themes:

- Identified organizational practices
- Communication aspect of AWP implementation
- Cultural aspect of AWP implementation

5.1. FINDINGS FROM RT 272

The team has worked on developing a set of functional capabilities documents that allows the clarification of the functional side of Advanced Work Packaging implementation. Indeed, the team has not only worked on linking the positions and functions to each step of process in the practice model but has also provided job descriptions of the new position recommended to be added with AWP implementation and also of the existing traditional positions that will have minor changes to accommodate the Advanced Work Packaging process. Below is a screen shot of one of the AWP Project Integration Flowcharts (PIF)?

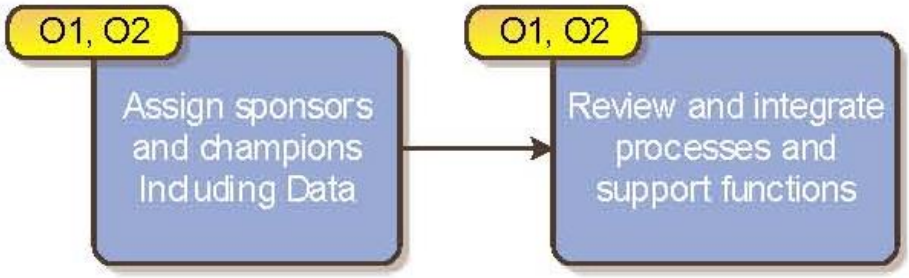


Figure 43 Screenshot of two AWP FIP tasks with functional roles

In Figure 45, O1 and O2 refers to two roles in the Owner (O) group. In fact, O1 refers to the Project Manager role for Owner and O2 to the AWP champion role for owner. For each step itemized within similar boxes in the AWP Project Integration Flowcharts (PIF), the roles involved in this step are added to the flowchart. Below is a chart that summarizes the list of the roles described in the implementation resource IR 272-2 volume II:

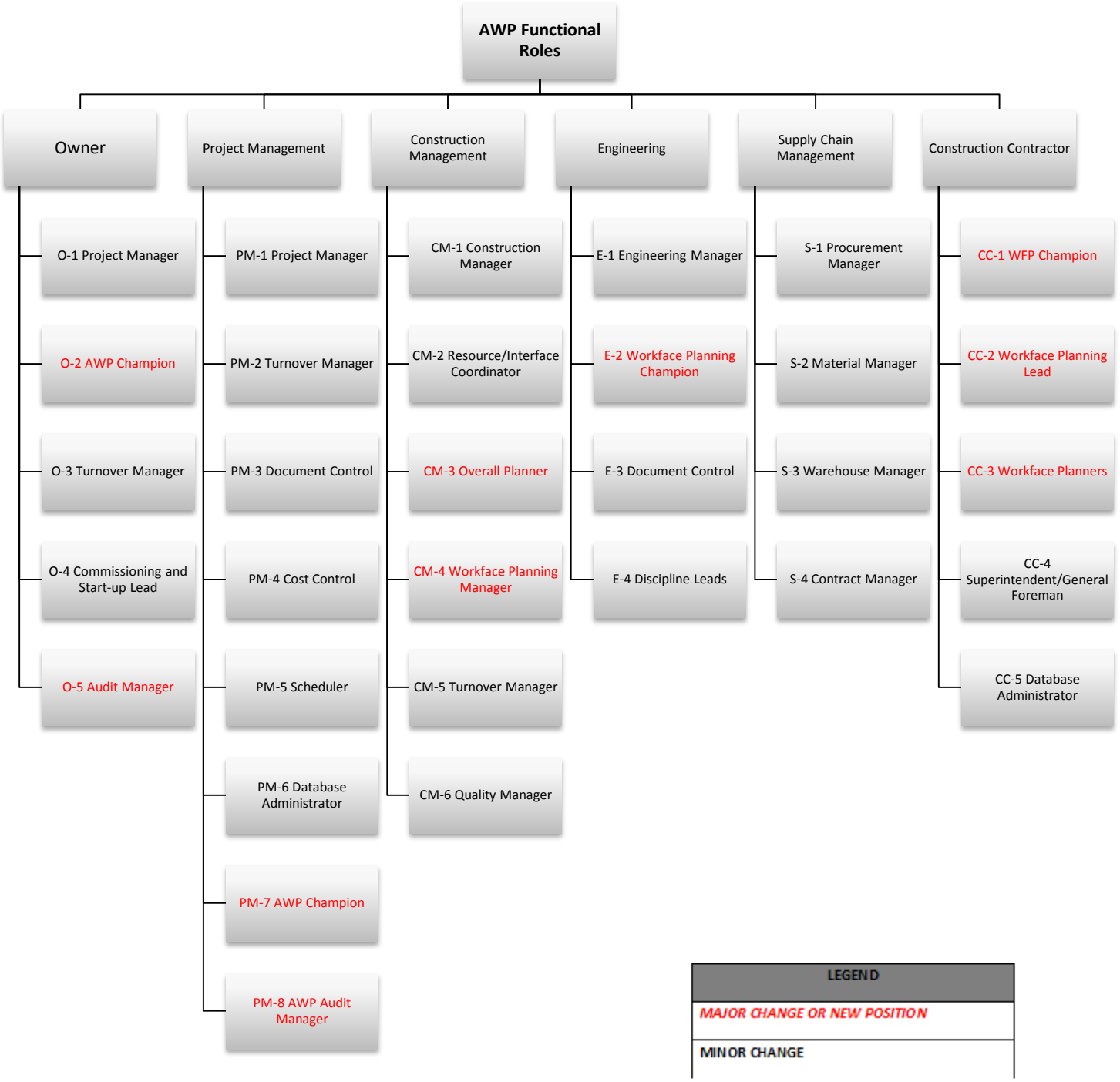


Figure 44 AWP functional Roles per stakeholder

All descriptions of each of those roles with respect to Advanced Work Packaging functions are available in Appendix F of IR 272-2 volume II. These roles are divided into two main groups: roles which are newly introduced because of AWP model requirement with those which have gone through major changes or existing conventional roles that have minor modifications to meet the integration of AWP in the organization. In the figure above, group of roles that are new or significantly changing within the scope of AWP are highlighted in red color. Below is an excerpt from the descriptions of those roles available in Appendix F of IR 272-2 volume II. We have chosen to report in this thesis two examples, one from each group:

GROUP – PROJECT MANAGEMENT

PM – 7 AWP CHAMPION / MANAGER
Sample Job Description:
Job Title: AWP CHAMPION / MANAGER
Reports to: Project Manager
Prepared by:
Prepared Date:
Approved By:
Approved By date:
Summary

This position must be a senior member of the project organization who has the mandate and authority to ensure that all stakeholders reporting to the PMT comply with the AWP Strategy for the project

This organizational role may be a new position or alternately be covered by ensuring that an existing senior member of the organization takes on the associated roles and responsibilities required.

- Essential Duties (Roles and Responsibilities) include the following:
- Ensure all contracts include terms and conditions that will ensure compliance with the AWP strategy for the project.
- Lead the Change Management involved with implementing the AWP strategy.
- Report to Project Manager on status of stakeholder alignment and any necessary actions needed for improvement.
- Be active participant and supporter for the AWP Strategy and fully understand the responsibilities matrix to successfully implement this strategy.
- Responsible for development and implementation of the AWP communication and training plan.

The following is a job description of a tradition position that will have minor changes: project manager for owner:

GROUP – OWNER

O-1 OWNER PROJECT MANAGER

Suggested changes/additions to typical job description to support AWP:
Job Title: Project Manager
Reports to: Project Director
Prepared by:
Prepared Date:
Approved By:
Approved By date:

Summary

This is the senior position in the Owner's Project Organization and has overall control and responsibility of the project and is responsible to steward the development and execution of AWP to the Owner's Project Director.

This is not a new position on the Organization Chart, however this individual will need additional training to understand all aspects and their role within AWP for project life cycle

Essential Duties (Roles and Responsibilities) include the following:

- To ensure AWP is the process used by all stakeholders from initial development through to the commissioning and start-up of the project.
- As AWP is a top-down driven process, this position must be seen as actively supporting the strategy and understand the responsibilities matrix for AWP.
- Clearly communicate the expectations that all stakeholders utilize AWP including willingness to remove non-supporters of the process from the project.
- Assure resources assigned to the Project are knowledgeable in regards to AWP and their associated responsibilities.
- Ensure the Start-Up and Commissioning requirements are developed early in the project and that adequate resources are assigned to do this. Ensure these resources are actively participating in the integrated planning sessions throughout the project life cycle.

5.2. FINDINGS FROM EXPERT INTERVIEWS

Through the interviews conducted during this second phase of the research, we documented a range of organizational structures and practices used in the industry to

accommodate to the need of a properly implemented work packaging. For the sake of giving to the reader an overview of the industry state of the art with respect to the organizational aspect of work packaging, we present in the following subsection first an overview of the range of documented practices and hierarchies followed by a more detailed description of two main relevant issues to the work packaging organizational aspect: the communication between different stakeholders (more precisely, between construction and engineering departments and people) and secondly the cultural aspect of the work packaging implementation.

5.2.1. IDENTIFIED ORGANIZATIONAL PRACTICES

5.2.1.1. Level of change following the level of implementation

One of the first observations that emerged from the expert interviews is related to the level at which the organizational hierarchy is impacted by the implementation of work packaging. In fact, whether work packaging is implemented on the construction phase only (WorkFace planning) or some work packaging is started earlier In the FEED phase, the organization of the company and the management level impacted by the use of work packaging follow the level of implementation. For instance, within company C which is an owner specialized in the energy sector, there is a dedicated team of people working to ensure the success of the work packaging process that is implemented through three main stages; in fact, there are work packaging planners, material specialists, project managers, engineers and designers and all are involved depending on the stage with work packaging. There is also a dedicated project control organization within the project management office that takes care of tracking materials and vendor data and feeds the packages with the right updated information. Expert 3, a manager of nuclear projects, explains the structure reported below in Figure 45.

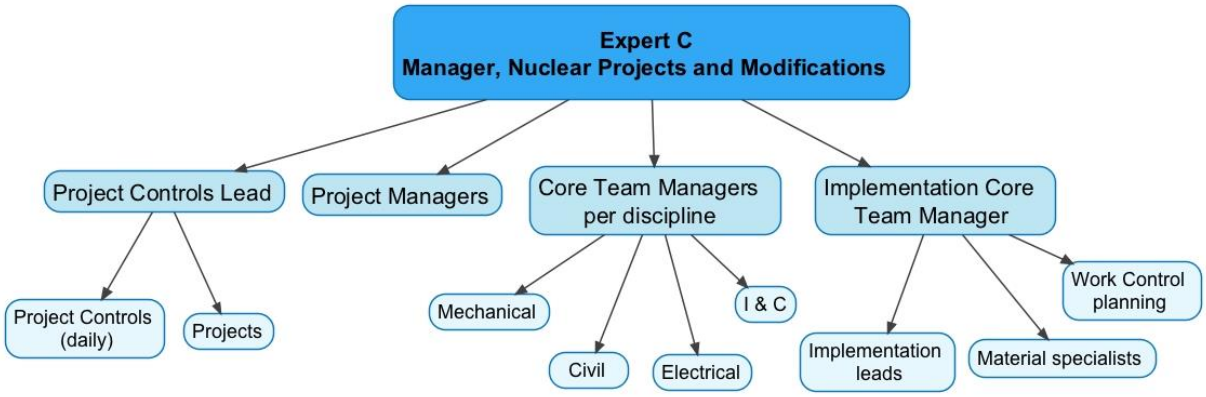


Figure 45 Organization of company C described by Expert 3

5.2.1.2. Official vs. unofficial change in the organizational aspect

From an organizational perspective, companies have two approaches to implementing work-packaging methods: they either adopt a formal approach and create new positions, especially the work packaging champion position, or do not consider a formal approach to the modification of an existing position. In general, companies that informally added new tasks related to work packaging (such as assigning to the project manager to be the champion of work packaging implementation without no formal support) to existing position were reported by experts to have had challenges related to the optimum execution of their own core tasks.

For instance, company D did not see any official change in its organizational structure following the introduction of work packaging. However, some other changes were noticed in the functional roles of existing positions: some people working in the agency ended working full time on managing the access database for work packaging to make sure every document was counted for. This was predictable because of the increasing number of packages and documents with the increasing complexity of the project over time. Four to five people were full-time on this process of database management for about 150 engineers and designers involved. Company D implements different work packaging systems on different projects. Depending on the project characteristics, the work packaging system is customized to meet the project needs and specific challenges.

5.2.1.3. Examples of functional roles and organizational capabilities documented through interviews

Table 5 Examples of functional roles and organizational capabilities documented through interviews

Expert interview	Example
Interview 1	- Packaging engineer is in charge of keeping coherent the packaging process and sequencing - Specialized team working on work packages: integrated scheduling and planner software
Interview 3	There is a dedicated team for work packaging composed by: • Work packages planners • Material specialists • Project managers • Engineers and designers.
Interview 4	Expert 4 is a project manager, the pioneer for the work packaging implementation.
Interview 5	During the FEED phase: EWPs and CWPs breakdown is done by a joint team composed by: ▪ The general contractor ▪ One owner construction manager and one owner project manager (client) ▪ An early work & module manger (Company) ▪ A WFP manager (Company) ▪ A general superintendent (Company) ▪ Construction engineers (those involved during the construction phase; some of them are present on field ➔ Audit: by the WorkFace Planning consultant and manager (general contractor)
Interview 6	• Integrators: a team of 10 integrators composed by foremen, general foremen and estimators was in place to build packages • A specific team was dedicated to the work packaging system • People dedicated to produce educating documents (interfaces people) explaining the process of work, the communication between people
Interview 7	• Construction managers are involved in all phases • The IFB (Issue For Bid) is issued • The owner asks the contractor for budget and schedule. • Construction managers, project managers and contract strategy managers work together to define CWPs. • The owner works with the GC to complete CWPs.

Table 5 (continued)

Interview 8	• Stakeholders led by construction people develop at an early stage the following sequences: 1. The construction sequence 2. then, the engineering sequence 3. and finally the sequence of procurement • 3D modelers become in communication with the construction side much more often (sometimes, on a full time basis). • WorkFace planners developed EWP and translate them in IWPs developed in the engineering office
Interview 9	Construction planning is an integral part of the design team, a dedicated full-time or part-time resource as part of the project team to accommodate construction planning. Work phase planning manager: (detailed engineering) only realizes the basic footprint for the 3D model, equipment arrangements, and a certain percent of the critical lines are available. Workplace planning manager: In the construction planning phase, he is sets up in the model to facilitate future detail planning and implementation.
Interview 10	A project management team, called PMT, does the scoping initiate involving many people: o reservoir geologist o business analytics o the engineering side o No people from the construction side involved at early stages but they are to verify the estimates concerning costs and materials They proceed this way: the company defines the schedule, does the WBS followed by the engineering house that crates estimates and costs, delivers the EWP. Those deliverables are reviewed by the company.
Interview 13	There is a position of WFP implementation lead that is currently not filled in (on the time of the interview)

Table 5 (continued)

Interview 14	• A project manager • Project management office • Project controls office 1. Coordinate the FEED phase and provide the level 2 schedule 2. Assure the alignment between of considerations of every stakeholders by readjusting ➔ Make the engineering side support construction from an early stage. ➔ Align the schedule, the cost estimate and the engineering with the breakdown as soon as possible ➔ Early consideration of procurement issues - Work packaging process is scheduled and coordinated by the project controls office
Interview 15	Two scenarios: The engineering firm is part of company L. Company L does the WBS The engineering firm is not part of company L. Company L realized a training on WFP if necessary and a joint discussion leads to WFP The construction manager or the superintendent represent the construction people (not involved in the FEED part) Engineering side always does the construction review process
Interview 16	The WorkFace planning process was inspired from the COAA model but was combined with Lean technique: Last Planner System (LPS). • A team is in charge of the schedule: included vendor, partner, manager, supervisor and other people (lean facilitators) • Progressive implementation (track of previous implementation)
Interview 17	For each project, there are: • A WorkFace planner • A scheduler • A Team who is not a project group, part of the company who defines the project's specificities: ensuring the readiness of the scope of work, drawings and materials in advance without the contractor Company people do the front end planning entirely The contractor is selected and works very closely and collaboratively to ensure the success of the project

Table 5 (continued)

Interview 18	• Dedicated resource for the development and maintenance of PWPs. • The materials management team is the one who is responsible for the maintenance of PWP. • The materials management team applies a "quality control" regarding PWPs. • The content is part of the engineering responsibility.

5.2.1.4. Communication between construction and engineering

Companies try to improve and increase the communication between stakeholders and particularly between engineering and construction sides. For this purpose, and according to the experts' interview, the best way to improve communication with the construction side is to have construction people at early stage. The earlier they are involved, the better understanding there will be. From the expert interviews, there are different ways to proceed to get construction people involved in the FEED phase: for instance, involve construction people, particularly construction manager, foremen during the FEED phase and the detailed engineering phases. Construction people, the construction manager in particular, is in charge of the process or the review of the work packages with the FEED team as well as engineering people. They are involved in the definition of work packages, so construction people would better understand the process and the value added to the project (Interviews 1, 3 and 9). Another method is getting construction people involved in a team dedicated to the WFP implementation (Interview 5) or organizing formal meetings like initiating compulsory meetings between construction managers and superintendents (Interview 14 and 15).

Informal meetings between the construction and engineering sides are common practice aiming to improve collaboratively on the project to ensure a better alignment between engineering and construction sides. This reduces conflicts and reluctance to work together

(Interview 4). The fact that informal meetings are frequent in the documented AWP implementations through interviews shows the spontaneous need to better occasions of communication between the engineering and the construction sides.

These efforts lead to a better involvement of construction managers, and as the construction manager and foremen are involved, the field crew will follow and execute the AWP process. Otherwise, if the involvement is not done at early stage, experts mentioned there will be no linkage between the different stakeholders and engineers will stay reluctant to work collaboratively with construction people.

5.2.2. CULTURAL ASPECT OF AWP IMPLEMENTATION

AWP implementation, independently of its level, did not happen without cultural implications to company employees and structures. In this subsection, we present three groups of documented cultural issues related to AWP implementation. Those groups are 1) the working habit and resistance to change, 2) roles and responsibilities change, 3) understanding of AWP and each stakeholders' contribution.

Working habit and resistance to change

Resistance to change is a very common cultural barrier evoked by experts during interviews. In fact, this is tight to all stakeholders from engineering to construction and from office based employees to field based employees. For instance, interviews 2, 3 and 5 brought the fact of understanding of the work packaging process that can be inefficient in the absence of formal and appropriate trainings and communication. Some can also be reluctant to implement this process particularly engineering people who consider that this process makes construction people work easier while it complicates theirs. People are more comfortable with their own method and tools which is one of the most barrier factor of the implementation of work packaging. Few remarks can be made regards this: resistance to change is bigger when the project is already in the field execution phase and leadership is needed to push the process (Interview 6). Also, AWP changed the focal point for engineering company: from the client &

customers to the owner and the construction side (interview 8). Expert 13 mentions that his company organized many trainings and formations to get foremen buy-in. their field crew had difficulties to accept the new process until Foremen started by-in. Similarly, change was difficult for expert 15 as he emphasizes the importance of the owner driving this implementation with the construction people being trained to think as owners. Expert 18 explains the obvious fact of people in the construction industry being comfortable with their existing tools.

Change in roles and responsibilities

AWP was accompanied in different cases by the creation of new positions and people being reallocated to different roles. Their new position usually requires different skills. They are not often prepared for this kind of change (Interviews 3, 7 and 13). Expert 1 shows for instance that there is a mmisunderstanding of the computer based work packaging method and he mentions that finding skilled people using the technological tool with at the same time having skills to embrace work packaging notions is difficult. Expert 3 talks about reallocation of some people from the maintenance department to the engineering and construction organization and how this impacts the work packaging functionalities. He mentioned the creation of a new position of management of work packages. Expert 7 presents another case of positions modifications that are the expanded functions of the WorkFace planner: involved in the WFP planning process from the front-end stage and CWP.

Understanding of AWP and each stakeholders' contribution

During the front-end phase, misunderstandings are due to the different way of "thinking" or of prioritizing work sequence between engineering, procurement and construction. This misunderstanding can get worse if only one department is trained and not the others (Interviews 4 and 15). Expert 4 explains that people have to work full time on managing the access database for work packaging. Engineers show resistance and do not like the concept. Expert 15 mentions that the difference of understanding creates inconsistencies. In fact, each contractor has to be familiar with WorkFace planning and has to learn the company way of using the work packaging

process. Expert 5 mentions the tendency to take planners away from the planning department and have them on field to do more supervision and field work.

5.3. VALIDATION AND DISCUSSION

Roles and responsibilities are, if undefined, a source of barrier to the best and optimum implementation of a process in a construction project. This applies to work packaging too, for which experts interviewed and Alberta community surveyed validated the importance of clearly defined roles in the proper implementation of work packaging during the project lifecycle (see workshop results in appendices). RT 272 provided the reader of the Implementation Resource IR 272-2 volume II with job descriptions for the purpose of enhancing the implementation of work packaging in accordance to the proposed AWP execution model. Yet, experts emphasize the importance of each stakeholder understanding of the process, independently of the roles definition. This is correlated to the efforts of education and training that should be done in parallel with the implementation. Education and training are not the only means of achieving stakeholder understanding of the process and its organizational aspect. In fact, alignment between stakeholders can happen through several means including an internal organizational process and dynamic of meetings and protocols that deliberately aim to enhancing the exchange between stakeholders with potentially conflicting interest.

CHAPTER 6. CONTRACTS

This chapter is a compilation of information related to Advanced Work Packaging contractual aspect. The chapter is structured around findings from the research joint venture between the Construction Industry Institute (CII) and the Construction Owners Association of Alberta as well as findings from interviews.

6.1. FINDINGS FROM RT 272

6.1.1. ASSUMPTIONS AND DEFINITIONS

The implementation report IR 272-2 volume II has a chapter dedicated to the contractual side of AWP implementation. The chapter sis composed of an introduction to the contractual aspect as follows:

> "The contractual requirements will cover the front-end engineering and design (FEED) phase, either self-performed by an Owner or performed by a contractor under contract to an Owner, and the engineering, procurement, and construction (EPC) phase, performed by one contractor or multiple contractors (i.e. EPC, EP-C, or E-P-C), all under contract to an Owner. Further, contractual requirements will specify and contrast the roles, responsibilities, and obligations of the Owner, Engineer, and Construction Contractor for effective implementation of Advanced Work Packaging (AWP) and Work Face Planning (WFP) depending on the execution strategies and contracting structures selected. Finally, tools have been provided to assist in the development of recommended contract deliverables for implementation of AWP."

One of the important assumptions is related to the minimum requirements of the selected contractor. The process is described as follows in IR-272 volume II:

> The consideration for contracting using AWP presented in this section must be complimented with the basic contracting principles required of any project to produce positive outcomes on the project. Basic contracting principles include utilizing established, financially sound, reputable contracting firms with the financial capacity commensurate with expected contract value and compensation type. Contractors invited to bid should also have:
>
> - Demonstrated experience executing projects of similar type and scope at the location under consideration.
> - A good safety record.

- Adequate work processes, systems, and tools for the size and scale of the project under consideration. People are familiar with and knowledgeable in the use of the work processes, systems, and tools.
- Adequate capacity to staff the project with experienced, knowledgeable people in key leadership positions.

6.1.2. FINDINGS

The contractual section is articulated around the following table, which summarizes AWP deliverables from FEED to Construction per contractual scenario. The table presented in the figure below is described by the research team as follows (IR272-2 volume II, 2013):

> Table 6 identifies three key, high level categories of deliverables that need to be produced through each stage of project development to ensure that Advanced Work Packaging is implemented correctly. The three key categories of deliverables are assessments, plans, and progress measurement.
>
> The table identifies tools and deliverables used or produced for each of the key activities and identifies the party accountable for two contracting strategies in the front end engineering design stage of project development and two of the most commonly used contracting strategies during the detailed engineering and construction stages.

Table 6 AWP contractual deliverables per contracting strategy (CII/COAA RT 272, 2013)

				EP-C		EPC	
	Deliverables	FEED by Owner	FEED by Contractor	Detailed Engineering	Construction	Detailed Engineering	Construction
Assessments	AWP pre-qualification questionnaire	1	1	1	1 3	1	1 5
	AWP audit tool by phase *	1	1	1	1	1	1
Plans	AWP Execution plan *	1	4	2 3	3	5	5
	Contracting plan	1	1				
	Organizational plan / staffing plan	1	1 4	2 3	3	5	5
	Interface Management plan	1	1 4	1 2 3	3	1 5	5
	CWP plan *	1	4	1 3	3	1 5	5
	EWP plan *	1	4	1 2		1 5	
	WBS (Aligned schedule with WBS)	1	4	1 2 3		1 5	
	Schedule structure	1	4				
	Estimate structure	1	4				
	Materials Management plan	1	4	2 3	2 3	5	5
	IWP Plan *				3		5
Progress Measurement	by CWP			3		5	
	by EWP			2		5	
	by IWP				3		5

* Additional deliverable for AWP

1 Owner 2 EP Contractor 3 C Contractor 4 FEED Contractor 5 EPC Contractor

6.1.3. TOOLS

To achieve the two functions of assessment and progress measurement, the team developed few tools that are defined below and are available in the appendices of the implementation resource IR272-2 Volume II:

AWP Contractor Prequalification Questionnaire

An AWP prequalification questionnaire has been developed in order to rapidly determine the AWP capability level of potential bidders. It is designed to supplement existing prequalification questionnaires which address other important attributes such as safety and quality. The prequalification questionnaire is included in Appendix B.

AWP Project Definition Assessment Tool

An AWP Project Definition Assessment Tool is provided to help project teams assess readiness before starting AWP implementation on a specific project. The tool is divided into different organizations/functional roles: Owner, Project Management, Construction Management, Engineering Contractor, Supply Chain Management, and Construction Contractor. These roles correspond with those in the AWP Project Integration Flowcharts described in Section 3. The AWP Project Definition Assessment Tool is not called out in Table 1, above, but should be used at project initiation and at the start of major phases, particularly when new organizations join the project. The AWP Audit Tool by Phase is complementary with the Project Definition Tool; effective project definition activities should lead to improved performance that will be shown during audits. The AWP Project Definition Assessment Tool is included in Appendix C.

AWP Audit Tool by Phase

The AWP Audit tool is meant to assess conformity to the AWP processes at each stage of the project. It is primarily for use by the Owner but can also be used by other parties to identify gaps in AWP implementation. Suggested assessment timings are included as steps in the AWP Project Integration Flowcharts (section 3 of this volume). The AWP Audit tool is included in Appendix D.

6.2. FINDINGS FROM EXPERT INTERVIEWS

As far as the contractual side of AWP implementation, experts almost all agreed on the importance of having contracts address a certain level of AWP implementation features like responsibilities and deliverable milestones. Some experts mentioned the structuring of contracts around construction work packages (CWP). For example, expert 5 thinks that contracts should be

organized around CWPs. He also thinks that a first agreement on the terms of use of WFP should be defined at the very beginning of the project. Similarly, expert 6 thinks that contracts help address the issue of conflict of interests between construction people and engineers; Originally, field engineers were the one building CWPs. The new process seems to take their work from them; this creates a feeling of frustration among them. First, a tension was perceived but soon, it disappeared because printing drawings from packages and discussing them with integrators brought clearer vision of the work and showed early detection of errors which reduced rework. Scenarios where a considerable number of players are involved were particularly emphasizing on the contractual side of AWP implementation. For instance, expert 7 mentions that because there are so many players in construction projects that are all involved in the work packaging process, it is very important to define contractually requirements for each player in order for the model to be successful once implemented. Vendors should also in his opinion be provided with needed info based on contracts too. A very deep level of detail is needed in contracts to avoid confusion and time & productivity loss because of legal issues. Main experts agreed that current contracts are not detailed enough and can easily bring confusion to the work execution. Expert 8 makes an interesting parallel with how safety has gone from being enforced contractually to being the rule for projects best performance. He mentions that the same way safety has gone through to get improved should be taken for work packaging. In her opinion safety improved because of the contractual requirements that owners initiated requiring trainings, Companies started improving safety because they were told to and awareness was increased mainly thanks to the contractual requirements. Contracts largely affect the behaviour and the work environment and methods. This is why expert 8 thinks this is a crucial part of the implementation. In an order of priority and importance, expert 8presents a levelling of work packaging information structure that is presented in the figure below:

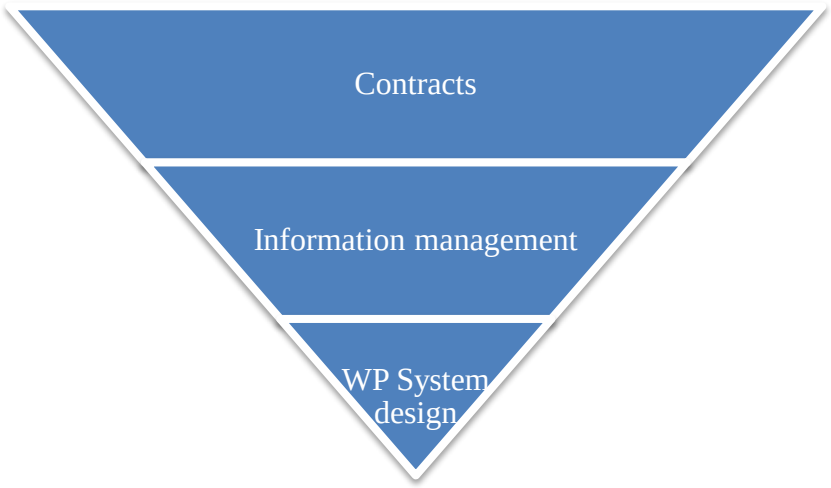


Figure 46 Work Packaging information leveling (expert 8)

6.3. VALIDATION AND DISCUSSION

The contractual aspect of AWP implementation is critical to the success of the process. The research team RT 272 has provided the reader with detailed contractual recommendations presented within the main contractual context of projects with a set of definitions and tools. Three out of the six experts interviewed for validation expressed their opinion on the level of detail of the contractual section of the Implementation Resource. In fact, they all thought that the section was too detailed and that it could be shortened. Other experts in contrary found the section useful for the context of reminding the basics and the assumptions for the following recommendations. This being said, the contractual aspect, although recognized by mainly all experts to be critical for the implementation experience and effectiveness of AWP, was not the main focus of interviews conducted. This explains the relatively short volume of information presented in this chapter compared to other chapters. This can be explained by the fact that the population of interviewed experts were mainly technically oriented with professional expertise related to project management and operations. Interviews with contractual experts might be more revealing regarding the dynamic that best describes AWP within the context of contractual scenarios.

CHAPTER 7. ENGINEERING WORK PACKAGING

7.1. INTRODUCTION

This chapter aims to provide the reader with an understanding of the industry status with respect to work packaging for engineering and work packaging during the Front End and Detailed Engineering Phases in general. The scope of the chapter is focused on the pre-construction phase for work packaging and the main objective is to give an overview of practices and experiences documented through the North American construction industry. Findings are organized around four main themes:

1. **The need for pre-construction work packaging**
2. **Process(es) and organizational aspect of pre-construction work packaging**
3. **Evidence of successful implementation of Advanced Work Packaging during FEED**
4. **Evidence of challenges preventing the implementation of AWP pre-construction practices**

Findings for each of those 4 themes are a compilation of findings from different sources: literature, RT 272 recommendations, expert interviews, as well as case studies.

Context and assumptions:

Before we develop the detail of findings related to the pre-construction stage, two main clarifications/ assumptions should be mentioned:

- The content of this chapter is related to previous chapters. In fact, previous chapters contain details about the AWP process, organizational perspective and contracts. Within those chapters, the focus was to cover the entire lifecycle and more specifically the construction phase. In this chapter, we present AWP FEED related information.

- The FEED phase definition: there are several terminologies in the literature that are used by companies to structure the FEED phase. We use in this section FEED per the Construction Industry Institute (CII) definition while recognizing that there are several other definitions and structures that were encountered during the interviews or the case studies. CII has a commonly known structure for Front-End Planning (FEP). CII defines the Front End Planning (FEP) as "the essential process of developing sufficient strategic information with which owners can address risk and make decisions to commit resources in order to maximize the potential for a successful project."

The following figure presents where does this specific phase stands in comparison to the entire project lifecycle.

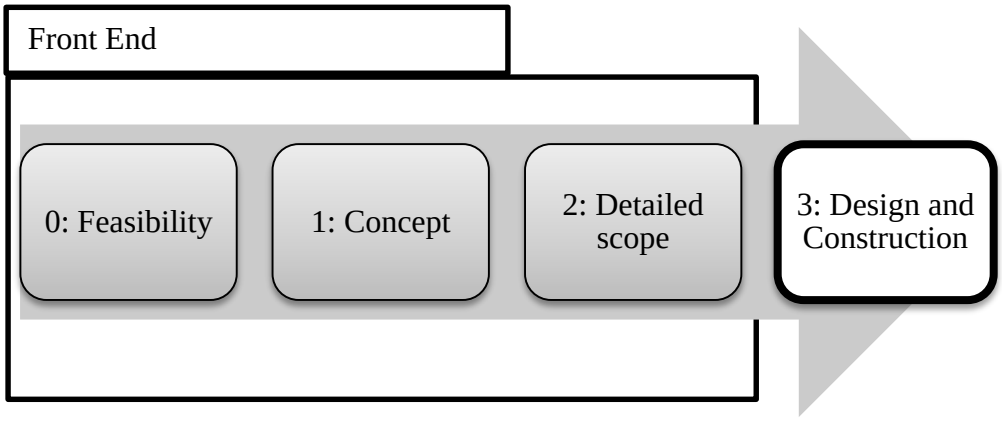


Figure 47 FEP and project lifecycle per CII definition (adapted from SP 268-3, 2012)

In the context of this chapter, we present findings for the pre-construction phases which includes then the feasibility, concept, detailed scope and design. Below is an excerpt from IR272-2 volume II presenting the research team definitions of Front End concepts as used for the AWP model recommendations:

> "Front end planning and detailed engineering activities support enhanced execution at the work front. Project setup and planning sessions establish the basis for coordinated construction and engineering work packages (CWPs and EWPs). These packages then

enable time progress of work through orderly planning, execution, and monitoring of installation work packages (IWPs). Management of IWPs is also known as WorkFace Planning."

Front End Definition: Typically includes all of the Preliminary Planning and Design as well as the Detailed Engineering (Stages 1 and 2 of AWP Project Implementation)

Front End Planning definition: Typically includes all of the Preliminary Planning and Design as well as the Detailed Engineering that is required to provide complete and timely Engineering Work Packages as defined in the Path of Construction to the Construction Contractor to support their successful implementation of WorkFace Planning during Construction Execution.

Those definitions in addition to a number of other terms are presented in the glossary at the end of the Implementation Resource IR 272-2 volume II.

Work Packaging and pre-planning

Work packaging enhances project management and allows for proper planning. Crew work packages require look-ahead planning, forcing foremen to plan their upcoming work in detail. This pre-planning facilitates coordination of planning among crews. CII explains that when validating crew work packages "the involved superintendents, foremen, and subcontractors must agree that the planned work is properly sequenced, supports the Control Schedule, and does not pose insurmountable interference or coordination problems" (CII RT 83-6, RS 6-6 1988). An important aspect of pre-planning is assuring resource availability. The development of work packages brings to attention shortages or other problems which may prevent or otherwise detrimentally affect planned operations in time for mitigation. Again, CII explains that, "resource availability for each work package must be validated before any task is firmly scheduled for the coming week (…). Once this is done, the availability of items can be checked with warehousing personnel and the feasibility of proceedings with that work task determined" (CII RT 83-6, RS 6-6 1988). Validation must be completed before the work package can be considered in the work

schedule. These validation measures ensure that the right items get to the right people at the right place and time in the field (Gardner 2006). Work packaging also encourages proper long-term and short-term planning to occur prior to work being performed. Site supervisors must agree with the scope and content of their work packages and plan their upcoming work in detail, leading to responsibility and accountability of work (CII RT 83-6, RS 6-6 1988). Proper work face planning includes ensuring the resources needed to execute upcoming work are available for the crews (Gardner 2006). The process of planning and removing constraints results in increased productivity in the field not only because materials and plans are available to the crew performing the work, but also due to greater crew motivation (Gardner 2006).

7.2. FINDINGS FROM RT 272

This section presents the research team findings and recommendations for best implementation of Advanced Work Packaging that are specifically related to FEED and DE. Presented below is an overview of those findings.

7.2.1. MATURITY MODEL AND FRONT END

One of the first tools developed by the team that allow an understanding of the company capabilities for AWP during FEED is the maturity model. Details about the maturity model are presented in chapter 4. We briefly present below an excerpt of the IR272-2 volume II that explains how the detailed assessment step allows the assessment of the FEED and DE:

> "Detailed assessment should allow development of a maturity assessment that depicts an organization that has achieved level 2 status in FEED and Detailed Engineering, but has level 1 capabilities in the other functions. Alternately, personnel who primarily operate in the FEED and Detailed Engineering functions might describe the organization as level 2 without understanding the limitations of the other functions."

7.2.2. CONTRACTUAL RECOMMENDATIONS AND FRONT END

As far as the contractual requirements for AWP deliverables are concerned, those will cover the front-end engineering and design (FEED) phase, either self-performed by an Owner or

performed by a contractor under contract to an Owner, and the engineering, procurement, and construction (EPC) phase, performed by one contractor or multiple contractors (i.e. EPC, EP-C, or E-P-C), all under contract to an Owner (see figure below).

Table 7 AWP deliverables per contracting strategy

	Deliverables	FEED by Owner	FEED by Contractor	EP-C		EPC	
				Detailed Engineering	Construction	Detailed Engineering	Construction
Assessments	AWP pre-qualification questionnaire	1	1	1	1 3	1	1 5
	AWP audit tool by phase *	1	1	1	1	1	1
Plans	AWP Execution plan *	1	4	2 3	3	5	5
	Contracting plan	1	1				
	Organizational plan / staffing plan	1	1 4	2 3	3	5	5
	Interface Management plan	1	1 4	1 2 3	3	1 5	5
	CWP plan *	1	4	1 3	3	1 5	5
	EWP plan *	1	4	1 2		1 5	
	WBS (Aligned schedule with WBS)	1	4	1 2 3		1 5	
	Schedule structure	1	4				
	Estimate structure	1	4				
	Materials Management plan	1	4	2 3	2 3	5	5
	IWP Plan *				3		5
Progress Measurement	by CWP			3		5	
	by EWP			2		5	
	by IWP				3		5

* Additional deliverable for AWP

1 Owner 2 EP Contractor 3 C Contractor 4 FEED Contractor 5 EPC Contractor

The contractual deliverables are centered as shown in the figure above around three main activities: assessment, planning, and progress measurement. Below is an excerpt from the implementation resource explaining how each of those is related to the Front End phase.

Assessment activity

Within this activity, a number of tools were developed and are recommended that are directly related to the Front End. For instance, the AWP prequalification questionnaire that is developed in order to rapidly determine the AWP capability level of potential bidders. This tool

is made for owners to use. Contractors also find guidance in the AWP implementation resource to be able to be prepared and assess their best way to respond to this questionnaire. This tool, among others, is part of the dynamic of the Front End phase that can included a bidding process, more or less, centered on AWP.

Planning activity

This key activity has eleven deliverables that must be developed and performed during the project development stage in order for Advanced Work Packaging to provide predictable project outcomes and productivity improvements during the construction stage. The development of the contract plan will only occur during the FEED stage and Engineering Work Package (EWP) / Work Breakdown Structure (WBS) planning will occur during the FEED and the detailed engineering stages. Other planning, such as Advanced Work Packaging plan, interface plan, Construction Work Packaging (CWP) plan, organizational plan, and material management plan, will be performed during FEED, detailed engineering and construction stages. When the owner self-performs FEED, all of the planning and deliverables produced will be the responsibility of the owner. When a contractor performs FEED, then the owner will provide a contracting strategy and will approve the contractor's organization structure. All other planning and deliverables will be by the FEED contractor with the exception of Work Face Planning (IWP Plan), which will be produced later during the EPC stage.

Progress measurement activity

"In order for an Advanced Work Packaging strategy to be effective, contractual language needs to include provisions to establish, measure, and report key metrics surrounding both the development and implementation of the spectrum of CWP, EWP, and IWP activities" (CII/COAA RT 272, 2013). CWPs and EWPs are critical items for the Front End phase. They are the center of the AWP process and measuring their progress is very critical to the success of the construction phase and execution of the project. The team gives a number of

recommendations regarding this topic. We present below a compilation of the recommendations that are Front End related:

- Associated contract(s) should clearly delineate the types, timing, and methods of reporting, and as much as possible, centralize and standardize the reporting tool itself and how it will be used to capture and integrate the data inputs and avoid duplicate work. The sequence of construction activities needs to be established early in the planning stage. This is critical to ensure that engineering sequences the work in a way that maximizes constructability.
- The project work breakdown structure (WBS) needs to be properly established so that progress through preliminary planning/design and the detailed design phases can be adequately monitored, i.e., aligning the CWP boundaries with the WBS can facilitate the progressing process via appropriate monitoring. If, alternatively for example, the WBS is by area and the CWP is by system, it would be difficult to relate the CWP to a percent complete schedule.
- An assortment of project indicators may be used to monitor the level of AWP success during different phases of the project life cycle. These may include but are not limited to: Package development schedule adherence, adherence to package release-to-work schedule, installation schedule deviations, number and types of requests for information generated in the field due to package errors, number and type of field change requests representing design or sequencing errors, number and type of engineering change requests that results in installation changes, late finishes, aggregate crew non-productive time, etc.

7.2.3. ORGANIZATIONAL RECOMMENDATIONS FOR FEED AND DE

The table below contains a compilation of examples of functional roles that are involved at the front-end within the AWP model recommendations as well as an extract from the implementation resource IR 272-2 volume II of specific roles that are directly related to the Front End involvement:

NB: The reader can refer to the entire description of each of those roles in IR272-2 volume II.

Table 8 Front End related positions (IR 272-2 volume II, 2013)

Position	**Involvement in Front End**
O3 - turnover manager for owner	Ensure the inputs/outputs that may change due to the AWP Strategy for the project database are established very early in the front end of the project to enable the project to effectively and efficiently steward the progress of the project and be able to turn over the project to operations as required.
CC2 - WorkFace planning lead	Be prepared to work in the Engineer's office if the strategy calls for early engagement of the Construction Contractor during the front end of the project.
CM1 - construction manager	Ensure qualified construction resources are appropriately engaged during the Front End to establish the CWP boundaries and the Path of Construction. Ensure resources are assigned to cover the interface planning during the Front End and to provide coverage during the construction phase.
CM2- resource/interface coordinator	This position will ensure that input is provided during the Front End integrated planning sessions as part of the development of the Path of Construction and ensure resources are provided to manage the interfaces during construction. Essential Duties (Roles and Responsibilities) include the following: Provide input during the development of the Path of Construction to ensure that the interface management will support the contracting strategy, the construction execution strategy and the transition into commissioning and start up. Ensure appropriate resources are assigned on a timely basis to support the interface management requirements of AWP. Establish draft resource plan in Front End integrated planning sessions. Track needed resource changes during design phases and develop final resource plan for WorkFace execution.

Table 8 (continued)

PM4- cost control	This individual has the overall responsibility to manage the project cost from the commencement of the planning in the front end through to the commissioning and start-up of the project. This would not be a new position on the PMT Organization, however this individual would require additional training so that they completely understand their role with the implementation of AWP.
S2- material manager	Ensure the planning and execution of logistics and warehousing is developed early in the front end of the project.
PM-1 project manager	This individual has the overall responsibility to manage the Project Management Team from the commencement of the planning in the front end through to the commissioning and start-up of the project.
PM-5 scheduler	This individual has the overall responsibility to manage the project schedule from the commencement of the planning in the front end through to the commissioning and start-up of the project.

Functional groups such as Construction Management have general key points to the best integration of AWP.

7.2.4. IMPLEMENTATION PROCESS RECOMMENDATIONS FOR FEED AND DE

Overview of the AWP Project Integration Flowcharts

The Advanced Work Packaging Project Integration Flowcharts (PIF) is a tool that illustrates how the key functions and activities of AWP can be integrated into a traditional project delivery model in order to achieve maximum benefits from AWP Execution. The reader can find more details of those flowcharts in chapter 4 as well as in the implementation resource IR 272-2 volume 2. Below is an overview of the Front End related recommendations from a process perspective per stakeholder (stage 1 related recommendations):

Table 9 Front End related process recommendations per stakeholder (IR272-2 volume II, 2013)

Stakeholder – functional group	**Key recommendations for best AWP integration from Preliminary Design to Detailed Engineering (stage I and II)**
Owner	Champion the overall AWP Project Execution including FEED and DE
Project Management	Early incorporation of AWP Strategies into Project Execution Plan Project Management will be required to demonstrate their AWP capabilities and capacity to the Owner. The Project Management team will work closely with the Owner on the actions detailed above for the Owner during detailed engineering. Selection of AWP qualified contractors Enforce AWP Execution throughout the life of the project The Owner needs to stay actively involved during detailed engineering in an oversight role to help keep project priorities in focus and assure continued alignment and execution according to plan.
Construction Management	During Detailed Engineering, Construction Management is responsible to monitor progress of the project and ensure compliance to AWP requirements to facilitate the Construction Execution activities in Stage 3 Construction Management plays an early role in preparing the project for AWP Execution
Engineering Contractor	Schedule EWP completion to support Path of Construction Report Engineering Progress at the EWP level During Stage 1 of the project, Engineering should be involved in construction planning to develop a plot plan and EWP boundaries that support the CWP definitions and path of construction identified by Construction Management. Toward the end of Stage 1, the Engineering Contractor prepares the preliminary EWP release plan, which supports the AWP and CWP Plans, and issues it for consideration during the development and review of the Level 3 Project Schedule

Table 9 (continued)

Supply Chain Management	Establish a Contracting and Procurement Plan aligned with AWP Ensure AWP Requirements are written into contracts and purchase orders with respect to execution, reporting and scheduling Active involvement of the Supply Chain Management in the Preliminary Planning and Design Phase of a project is necessary to achieve realistic schedules with committed participants and to ensure that execution of suppliers' and contractors' scope of work fully supports AWP Execution on the project. Proper attention during Stage 1 creates an environment to complete the project successfully utilizing the As the project changes from Preliminary Design to Detailed Engineering, Supply Chain Management maintains responsibility to purchase materials in a manner that supports the EWP release plan and the Required At Site dates for proper IWP planning and execution concepts of AWP.
Construction contractor	Involved in the end of Detailed Engineering during the overlapping period. Throughout the final portion of Stage 1 and Stage 2, the Construction Contractor should focus attention on supporting the refinement of the overall project execution plan and development of a Level 4 Construction Schedule utilizing IWP's as the basis for planning.

The implementation resource also contains a narrative about an owner experience with AWP integration. This narrative included the owner experience from Early Planning to detailed Engineering phases. The reader can refer to the entire narrative in the IR272-2 volume II.

The Implementation resource contains also an example that depicts the AWP integration from stage I to stage III (construction). "The objective of the example is to illustrate how the basic work packaging concepts are implemented. The principles of AWP are used to develop the details of an execution plan that can be easily correlated with standard project execution methods. Sample documents are provided in the context of a real life project. A pumping

station, part of a larger industrial project, is used as the basis. The Implementation example was chosen to provide variety of disciplines and contractors." (CII/COAA RT 272, 2013)

Below is an excerpt from the example explaining Stage I Preliminary Planning/Design and Stage II Detailed Engineering:

> Stage I: Preliminary Planning/Design:
>
> At this point a few rules should be verified. All engineering activities relevant to installation have been packaged and assigned to a single CWP and there is no overlap across CWPs. There is a one-to-many relationship between CWPs and EWPs.
>
> and Stage II Detailed Engineering
>
> Once planning and preliminary engineering is setup as shown above, the basic project controls coding will be in place to support management by CWP and EWP during detailed engineering.
>
> Inputs: CWP and EWP and Engineering Procurement Plan by CWP
>
> In this stage a detailed plan is developed based on the outputs from stage I. Other documents and outputs from Stage I are not specifically mentioned but it is assumed that they are produced and used in the detailed planning phase. All documents generated are basis for control and communication.

7.3. FINDINGS FROM EXPERT INTERVIEWS

7.3.1. THE NEED FOR PRE-CONSTRUCTION WORK PACKAGING

Existing literature has clearly established that an effective front end planning process contributes to enhanced project performance in the construction sector. For instance, work packaging is perceived to be a framework that allows the optimal execution of construction projects. Companies do some level of work packaging for at least the construction phase. However, it is still not an industry standard to have companies carry the work packaging formal effort from early project definition to turnout. A number of the experts interviewed expressed the need for having this process be extended to more than the construction phase while at the same time, few other experts mentioned that Advanced Work Packaging cannot be extended to the

FEED phase in all contracting scenarios. The following findings are testimonials aiming to present an idea about how work packaging for FEED is perceived and/ or needed.

Expert 1 mentions the challenge of required skills for work packaging that the construction industry needs in his opinion to overcome. Indeed, he mentions that packaging engineers usually lack competencies in computer-based work packaging methods. He thinks that finding skilled people (with capacities of understanding the work packaging process as well as using the technological tool) is a challenging fact for his company and for the industry. This is a matter of competencies that, for work packaging to be successfully driven from the FEED phase, are needed to be accurately developed within companies and across the industry. Several experts mentioned that work packaging is usually not formally implemented through FEED while recognizing the impact of how work packages are designed on their project execution phase. For instance, expert 4 mentions that design and construction get overlap at about 25% of completed design. His company decided to implement a specific work packaging system shaped to the project characteristics aiming to support the contracting schedule. This decision was made after FEED as no specific work packaging system was used previously. After implementation, for this project, a significant number of people expressed satisfaction of the work packaging process in resolving the complexity of the project. They recognized its value in increasing communication between different stakeholders and in decreasing different types of conflicts. Involved people think that this project would be unmanageable without this work packaging system because of its increasing complexity with time.

Other experts also highlighted the fact that people in the field lack education over the work packaging process when implemented from the FEED phase. Expert 5 thinks that different stakeholders do not understand WFP process in its enhanced version going from the FEED to the construction phase. Once IWPs are issued in field, the beginning of their usage is slowed down by the lack of education. This is also an obstacle for the communication between people. Expert 5 points out by this reported experience that a more integrated work packaging process involving different stakeholders during the entire project lifecycle requires a minimum of education to the

key stakeholders as far as the importance of FEED stage in delivering and preparing the package. He thinks that this is a critical factor to the management buy in of the process and its effective and complete implementation. Expert 5 recommends bringing the construction people involved in the scheduling process too. He thinks that the management staff should keep in mind always making stakeholders move as a team and make regular audit of the process. This piece of recommendation is part of what has documented through interviews and case studies. It was noticed for the range of companies studied and the range of experts interviewed that levels of AWP implementation are different despite a common consensus on the importance of implementing a minimum of formal work packaging for the construction phase.

We present in the following section a range of processes and practices that are specifically related to the FEED phase. The reader can have a more complete overview by referring to Chapter 3 of this report and to RR 272-21.

7.3.2. PROCESS(ES) AND ORGANIZATIONAL ASPECT OF PRE-CONSTRUCTION WORK PACKAGING

7.3.2.1. Work packaging organization around FEED

The FEED phase is basically the phase during which the scope of the project as well as the plan and the design are prepared to a certain extent. Work packaging during this phase plays the role of the structure that allows the production of workable packages in the field. This involves the formation of construction work packages, engineering work packages that combined, will be converted to installation work packages which are at the center of the construction phase. For expert 1, a workable engineering package is a package with parameters defined by the construction side on how to have work performed on site. It does contain engineering drawings by discipline. Disciplines in work packages are classified to minor disciplines and major disciplines. The EWP break down is consistent with the CWP breakdown. EWPs feed CWPs with drawings and other requirements. This definition is common to several experts with the exception of considering an EWP not as a separate deliverable but as the

engineering work or design. The several ranges of definitions and content of EWPs are presented in chapter 4; however, the main point relevant to this chapter is related to the organization of those packages in the FEED phase. For instance, at company C, an EWP containing typically about 25 to 50 drawings and specifications has the following formal and standard structure:

- Scope of work section
- General impact plan
- List of documents, such as: plans, drawings, design calculations
- Separate documentation issued for needed support
- Change evaluation

This structure is set up and completed at about 30% of design which represents the first of the three sub phases of FEED. For expert 5, the project he cited has a FEED phase that lasts one year. During this phase, the conceptual engineering work delivers the list of Construction Work Packages (CWPs). The basic breakdown is by area. Each area is divided to a certain number of Engineering Work Packages (EWPs) based on an areas too. Typically these EWPs are modules that are delineated into Construction Work Packages (CWPs) which are discipline based. The area breakdown, EWPs and CWPs breakdown is done by a joint team between the general contractor and the client as well as a number of leads from different discipline contractors. This entire process is done during the FEED phase.

FEED typical deliverables

The FEED phase deliverables in terms of work packaging are typically the list of CWPs as well as EWPs whether being considered packages or drawings. The example of company D is cited below as during the FEED phase are developed typically:

- A preliminary Project Execution Plan (P.E.P); this plan will be refined as the project is more detailed.
- A preliminary Construction Execution Plan (C.E.P); this plan will be refined as the project is more detailed.
- The list of EWPs

- The list of CWPs
- The list of IWPs
- A high level schedule that is updated as soon as a change occurs and more detail is available

FEED organizational aspect

The FEED phase requires for work packaging both modifications to the existing job functions of a number of people involved in the project as it might require the creation of new positions. This has been explained into greater detail in chapter 5. Within this chapter, an overview of few practices of FEED organization from a responsibilities and positions perspective.

For instance, expert 6 explains that within her company the title of "integrators" is a critical component of succeeding in work packaging during FEED. In fact, a team of 10 integrators was in place to build packages; these integrators are usually people from the field (foremen, general foremen and estimators). They have to be able to communicate with people in the field with the same language as they are used to. Integrators have skills in planning but are not planners.

This is part of the creation of a specific team that was dedicated to the work packaging system; basic tools were provided (computers, equipment) and additional effort was done to bring all involved people in one place under meetings. Expert 6 reports that it was noticed that some discussion happens just when people meet face to face; this helped raise issues and discipline conflict early. For instance, electricians and pipers did discuss issues during the meetings in the office, something that they never did in the field. Expert 6 points out the benefit of having formal meetings in an office for the field people; this environment ("around office tables") seems to bring more serious discussion. Expert 6 believes also that somebody dedicated full time to the implementation and coordination of AWP should be in place. Company D is an example of a company that formally established FEED processes for work packaging including producing educational documentation for implementation. This happened in parallel during

FEED where there were people dedicated to produce educational documents (called “interfaces people”) explaining the process of work as well as the communication between people.

Another aspect of the organizational perspective is related to the change that AWP brings to the number of people and teams involved in the pre-construction phase. In fact, there is no general trend over the reduction or the increase in the number of people involved with AWP in the pre-construction phase. However, one might make the following observation from one of the expert interviews: even though no official change was done in the organization and the functional capabilities of the project team, some other changes were noticed: for instance, expert 4 related that some people working in the office ended working full time on managing the access database for work packaging to make sure every document was counted for. This was predictable because of the increasing number of packages and documents with the increasing complexity of the project over time. 4 to 5 people were full time on this process of database management for about 150 engineers and designers involved.

7.3.2.2. Communication between construction and engineering during the pre-construction phase

During the construction phase, it is commonly assumed that engineering and construction sides should be communicating in an efficient and clear manner. For the FEED phase, experts commonly agreed on the same need for better communication but in practice, there is still a gap between companies about establishing the proper means for enhanced communication between both sides. In fact, in the context of work packaging which is directly related to structuring the project execution plan, few documented companies present enhanced practices for best results and integrated work. This has been developed in detail in chapter 5 but we present hereby an overview of FEED related practices. The main common practice is to bring construction people to earlier involvement in the project. Other practices involve, as presented by expert 3, the creation of a dedicated team with specific champions that work on linking both sides and moving the work packaging process forward. Tracking work packages is recognized as being a function that links stakeholders from different sides and aligns them. Few relevant themes can allow the

characterization of the communication/relationship nature of construction and engineering people within the pre-construction phase for AWP. Those themes are as follows:

Meetings dynamic

Several experts emphasized the benefits of having face to face meetings in addition to any other form of communication and deliverable. Expert 3 mentions that there are core holders meetings between each design point: between the 30% and 60% and between the 60% and the 90%. The objective of such meetings is to help flesh out the engineering work with more details as well as review the performed design work. The presence in these meetings is compulsory. He also describes that installers are involved in the 30% phase which helps taking into consideration construction issues at a very early stage. For the construction people involved within these formal meetings, there is a set of formal deliverables that they should provide after the review process. There is a special review guideline to help the construction people get involved at early stages. This review guideline contains a list of questions that should be asked during the review process. Similarly for expert 4, during early stages of design, construction people were involved in a formal and an informal way. In fact, they were involved in the constructability review process, in reviewing the first design developments and later in the construction review. Formal meeting involving the construction and procurement side are scheduled in a regular basis. There is a heavy informal exchange between the construction side and the engineering side. Expert 4 emphasizes on the importance of those meetings.

Team formation and tasks executed

Several companies have different teams that are formed to be the core executor of work packaging during pre-construction. The most complete team that we have documented during interviews was presented by expert 5 as follows:

During the FEED phase (which lasted 1 year for this project), people from the construction side were heavily involved. Expert 5 considers this as a critical success factor for the project performance as well as the work packaging system implementation. The following

people work together during the FEED phase to produce the best work structure and constructability plan for the project:

- A construction manager from Company D (general contractor)
- An early work & module manger (Company D)
- A WFP manager (Company D)
- A general superintendent (Company D)
- One owner construction manager (client)
- One owner project manager (client)

Construction engineers (those involved during the construction phase; some of them are present on field). This team is expected to take part in the modules reviews, be very involved in the scheduling and planning process by attending meetings and generating reports. Expert 5 says that this heavy involvement of the construction people from a very early stage is uncommon within the Canadian construction industry. The specificity of this process is that all levels of supervisors are involved from a very early stage. Expert 5 thinks that not having the field level of supervision involved is a big obstacle in front of the successful implementation of work packaging. In fact, one of the most important factors for the successful implementation of work packaging is the buy-in of all levels of supervision of the process. Some of the experts interviewed mentioned that late implementation of AWP was a cause preventing the early involvement of construction people in FEED. Expert 6 explains that for the project, construction people were not involved in the FEED. The late implementation of WFP is one of the reasons; previous work packaging system was not creating the linkage between construction people and the engineering side at an early stage.

As far as functional involvement of construction people during FEED, Expert 7 mentions that construction planners are typically part of project controls but within his company G, they plan construction execution with consideration of constructability issues, labor and management considerations. He also mentions the role of construction managers coming in before execution and working on the plan path of construction as well as on CWP definition.

Financial aspect

Many experts mentioned the cost of implementing formal AWP but few actually emphasized on the budget for bringing construction people to be involved much earlier in the pre-construction being an eventual significant cost preventing the optimum communication between construction and engineering people. Expert 1 mentions for instance that as soon as the plan is ready containing construction work areas and construction work packages, the FEED team sends this plan to the engineering side to start working with. This plan is mainly produced by people from the Construction side. He also mentions that there is also a budget allocated to have construction people involved during the FEED and DE phases to develop formal and informal constructability information, input to scheduling people, input to budgeting team. Expert 1 and 7 mentioned that this budget can be a burden for regional offices or some companies to fully create a formal communication between engineering and construction.

7.3.3. EVIDENCE OF SUCCESSFUL IMPLEMENTATION OF ADVANCED WORK PACKAGING DURING PRE-CONSTRUCTION

Table 10 Perceived benefits for AWP pre-construction implementation per expert interview

Expert Interview 1	Success factors: Consider WP as a FEED product Reduced man hours by assembling packages Easily enhanced by technology
Expert Interview 2	More control of owner Works well for in house engineering Enhanced departments communication Optimum constructability and field constraints consideration early
Expert Interview 3	Provides structure Good way to make engineering scheduled Measure in advance Certified project management

Table 10 (continued)

Expert Interview 4	Facilitated detailed engineering disciplines Better alignment between construction and Engineering Reduced engineering & construction cost Contracts by work packaging
Expert Interview 5	Saved budgetary cost More organized work / faster Reduced man power -> safer work Enhanced productivity Optimized scaffolding system Improved morale and good atmosphere of work
Expert Interview 6	Material management: improved efficiency of material delivery Built team work Tools to track the numerous work packages
Expert Interview 7	Scope of work well defined Measurement of the packages Success factors: Better control New to people, there is potential Regulatory requirements are well detected and brought to surface
Expert Interview 8	Opportunity for better Information management Opportunity for enhanced Material management Fostering cultural resistance to more integrated project executions
Expert Interview 9	Anticipated cost addressed properly Facilitated discussion Work packaging process by discipline plays a key role in how the overall effectiveness of the project is enhanced by selectively carving out those portions of the work that have adequate definition to obtain a competitively bid lump sum proposal. Especially contractors who perform in that manner.

Table 10 (continued)

Expert Interview 10	Emphasis on Project Controls critical role to the implementation of AWP during FEED and DE
Expert Interview 11	None
Expert Interview 12	None
Expert Interview 13	Better communication Schedule by IWP WBS lineated with WFP structure Easier control and adaptation to the workforce conditions of the Canadian market (shift schedules)
Expert Interview 14	Logical way and easy to understand Facilitates for project manager to situate their work status in a big and complex project
Expert Interview 15	Value of WFP depends on the project size Owners efforts to drive the process Need for a WorkFace planning champion
Expert Interview 16	Productivity improvements: 15% to 20% productivity improvement in 2011: 3500 hour work with zero accidents in 2012: 3800 HW with same safety performance; equivalent to 30% improvement in productivity Productivity is analyzed with safety performance.

Table 10 (continued)

Expert Interview 17	AWP helps in managing mining processes as new technologies get introduced – early planning for new constraints Best bid quality to help contractor respond in the most accurate way More quality in the contractors selection process Pricing and quality are well balanced in the selection process as AWP provided early planning and design quality
Expert Interview 18	More collaborative work environment. Engineering deliverables being vital to the Procurement side to work, early work packaging makes procurement department work more accurate and more predictable More reliable key procurement milestones Procurement work packages as a great tool to monitor procurement work Quality control by material management team
Expert Interview 19	Advantage to having boundaries fixed so you can have tracking during the project Economic incentive to keep plans up to date in what you are doing EAC company can keep plans up to date and publish them Get to huge gains by staying with plans. Plans can be correlated across divisions across company Automation increases productivity

Enhanced Pre-Planning: evidence from case studies

With different levels of maturity and early implementation of WorkFace planning, many planners cited that construction involvement in detailed design and early construction planning allowed issues to be identified and mitigated prior to execution. The early identification of issues during the planning phases allowed the construction team time to take corrective action so that delays and expenses could be avoided in the field. Mitigation of issues led to increased project quality and fewer RFIs, rework, and field fits. For example, through thorough development of

the IWPs, several companies found a reduction in field changes as most of the changes were identified and mitigated during the planning phase of the project rather than during execution when labor costs are highest. Below are findings that are extracted from the set of validation expert interviews presented the research Report RR 272-12 (Meeks et al., 2011). Those findings are related to the role of AWP in enhancing pre-planning. *(Reference to experts below is based on the coding of expert interviews in RR272-12).*

> "Expert A considers Advanced Work Packaging to be a more disciplined and structured approach to what companies already know they should do, namely front-end construction involvement and thorough construction planning. Expert A found the primary difference between the proposed model and current industry practice to be the removal of constraints prior to the release of work for execution. This constraint removal has a ripple effect on the project lifecycle to emphasize the support of construction in all stages, requiring early construction input. Additionally, Expert A considers the Advanced Work Packaging process to provide an appropriate level of guidance to companies without being too prescriptive. This balance is important in supporting proper practices without removing the responsibility and authority of those executing the work. Expert A placed great importance on developing a solid framework instead of prescriptively telling contractors how to perform their work.
>
> Expert B noted that Advanced Work Packaging emphasizes early design development that requires a mix of team members that are usually not brought onto the project so early on. Expert B believes that this step change in early design development gets the right people involved early enough to be able to positively impact execution and produce less change, due to a better defined scope of work. The expert noted that in many projects today, when a constructability review is performed there is not enough time to assemble packages and truly impact construction. With a background in planning and scheduling, Expert B believes that Advanced Work Packaging helps to eliminate project risks and manage costs due to proper resource loading and awareness that occurs during planning and work package development.
>
> Expert C found Advanced Work Packaging to be a great tool to draw the workforce around the work to be performed. IWPs define the work scope and detail specific requirements, such as man-hours and materials, and necessary documents, such as relevant ISOs. Additionally, work packaging encourages short-term planning for IWP execution and emphasizes constraints removal, including materials and safety, which forces the workforce to consider and prepare for these aspects of the work to be performed. Expert C has seen indirect costs for items such as scaffolding increase within his company due to a reduction in planning and organization around scarce resources. The constraint removal emphasis of work packaging causes questions around the use and sharing of resources to be discussed in the planning room before an IWP has been issued

for installation, instead of during execution. Expert C noted that proper execution of work packaging processes could greatly reduce indirect costs of scarce resources."

7.3.4. EVIDENCE OF CHALLENGES PREVENTING THE IMPLEMENTATION OF AWP PRE-CONSTRUCTION PRACTICES

Table 11 Perceived Challenges for AWP pre-construction implementation per expert interview

Expert Interview 1	Inconsistency in execution Having price contract based on alliance to the best value for the dollar
Expert Interview 2	Following the changing scope Different levels of detail Experience with regulations
Expert Interview 3	Inconsistency in execution Having price contract based on alliance to the best value for the dollar
Expert Interview 4	Stakeholders buy-in (cultural challenge) Following the changing scope Different levels of detail Experience and training
Expert Interview 5	Lack of senior management buy-in Lack of education Quality and price of work packaging training and consulting Re-allocation of planners to the field -> distracted WorkFace planners
Expert Interview 6	Resistance to change Weak material tracking system WFP is very interdependent process Knowledge management
Expert Interview 7	Poor job of change management Expanded functions of the WF planner So many functions Number of simultaneously involved stakeholders

Table 11 (continued)

Expert Interview 8	Lack of consideration of construction in early stages is a weakness of the WorkFace planning system and should be enhanced WorkFace Planning is still in early stages of implementation in the industry…so results are not very well documented. WFP applied to engineering is a rare practice. Engineering think systems Procurement think commodities Construction think all and geographically Different thinking complicated by culture
Expert Interview 9	Owners were reluctant to pay any more Challenges with getting census with all of the parties about a preferred method to go and so a key part of it is the ability to be resonant and communicate with the disciplines to better communicate " We have a lot of studies that we do here internally as far as a collaborative discussion so that's a team group so that we can get consensus for perhaps a decision that needs to be made but you want to have a consensus with everybody so that they understand why we arrived at the proper consensus."
Expert Interview 10	Incompatibility of Work packaging numbering structure with other companies Conflict in partnerships
Expert Interview 11	Culture and resistance to change.
Expert Interview 12	None

Table 11 (continued)

Expert Interview 13	Not all engineering companies follow the WFP process in the EWP release plan – Engineering companies don't always have the same way of doing the EWP release plan Owners and Engineering are still not familiar with the WFP system Tagging codes mixed During the implementation, owners did not pay for the extra indirect cost
Expert Interview 14	Incorporation of the execution sequencing Feasibility of the original plan Neglected enough procurement consideration The level of engineering work in FEED is usually very high level and depends a lot on the contracting strategy (DB, DBB) Conflicting work cultures Engineering efficiency is very important to engineering economics.
Expert Interview 15	When engineering firms are not familiar with WFP and work packaging, they need education provided by an external stakeholder (more likely owner) Experience of discipline construction engineers
Expert Interview 16	Late delivery drawings, weather impact, delayed material delivery is a challenge for the consistency of work packaging
Expert Interview 17	Early packages v later refined packages Challenging engineers' involvement in early construction management
Expert Interview 18	Procurement challenges ranging from the lack of effectively updated information to the missing tools and methods for properly and timely packaging procurement work.

Table 11 (continued)

Expert Interview 19	Technology related challenges • CAD have CWPs as package boundary • Paper or excel spreadsheet becoming a nightmare • Cannot track on paper • CAD models have evolving levels of details • Early CAD models aren't advanced enough to do packaging • Engineers were coding work packaging definitions into 3D models but were how to facilitate engineering processes but not necessarily construction process • Discipline to discipline- tools facilitate drawing of layout but doesn't break up into constructible elements • CWP boundaries aren't fixed, change management for construction companies People related challenges • Engineers saying we've been doing this for 10 years • Who is going to maintain the definitions as project evolves? • Construction responsibility • Engineering not responsible to maintain package • Engineering model-doesn't have granularity for how things are constructed, its design but not how to be constructed, just how it was designed • work packaging and engineering miscommunication • Cannot determine best way to build until finalize design process

Challenges as presented in the table above and as detailed in each of the interviews write-up can be classified based on different criteria.

For instance, one might classify those challenges based on the project component that is directly related to them. The example of identifying all technology and process related challenges versus people related challenges is a common one. In addition, the reader can benefit from the breakdown of those challenges into challenges directly related to AWP maturity level and challenges caused by external factors.

7.4. VALIDATION AND DISCUSSION

The Front End is a critical phase for the project success and planning process. This phase goes in parallel with AWP as proposed by RT 272. Companies implementing AWP tend to generally start tackling the construction phase only. In many scenarios, this was very successful (see benefits section), in others it turned out to be inefficient. Experts mentioned though that, in case of failure, the process was not properly prepared to be implemented. In the majority of cases, except in one interview, experts mentioned that the process has a great potential being taken beyond the construction phase.

CHAPTER 8. CONCLUSIONS AND RECOMMENDATIONS

Elements of the industrial construction industry have been implementing innovations in work packaging procedures to achieve higher levels of productivity and predictability. In particular, the Construction Owners Association of Alberta (COAA) has for the past several years been promoting the development of field productivity improvement processes they have called WorkFace Planning. Similarly, members of the Construction Industry Institute (CII) have been developing and implementing similar enhancements to traditional work packaging and planning methods. These efforts have reached the point where field implementation is showing a range of improvements and the practices have been codified as a recommended process called Advanced Work Packaging by COAA and CII. This thesis has presented through its seven chapters the description of this process through literature review and research findings conducted by the research team RT 272. The thesis contained a detailed description of Advanced Work Packaging processes, organization and contracts. It also included a more developed description of the Front End phase work packaging practices as documented through CII/COAA execution model and through interviews across North America. Those interviews were conducted simultaneously with the development of the execution model. The practices being performed by the companies studied and their associated success was instrumental in the development and validation of the execution model. Additionally, the execution model was validated by industry experts who noted its value and gave feedback on its place in the future of the industry. The research team provided organization and a solid structure to practices that are benefiting projects in industry today.

The team collected feedback in 2011 after the first phase of this research project and summarized the points to be addressed as following (extract from Meeks et al., 2011):

1. ***Evidence:*** *develop quantifiable evidence to form a stronger business case and provide further discussion around management and workforce buy-in.*
2. ***Contracting:*** *provide recommendations around contracting strategies and requirements and potential levels of implementation considering contracting constraints, such as construction-only contracting.*
3. ***Front-End Collaboration:*** *provide more detailed recommendations on how to achieve front-end construction consideration and collaboration between construction, engineering, and procurement.*

4. ***Organization:*** *provide definition around project roles & responsibilities, potentially through the use of a RACI diagram. Provide recommendations around successful organization structures and reporting hierarchies for enhanced work packaging.*
5. ***Information Management****: provide more details around the requirements of information management and document control for successful work packaging. Further discuss the importance of system integration.*
6. ***Technologies:*** *due to the great impact they can have on work packaging success, provide analysis of and recommendations around current technologies, such as modeling, virtual packaging, and material management systems.*
7. ***Metrics:*** *provide metrics to measure work face planning implementation success and the impact on projects.*
8. ***Tool Development:*** *develop additional tools to support the implementation of work packaging, such as CWPs, EWPs and IWPs samples and templates.*

The difficulties and successes of the projects and companies studied in expert interviews, especially concerning the Front End phase and early planning, in combination with the feedback received from the validation experts' points that the team has addressed several of those points. In fact, the following points, as presented in this thesis and in the research team deliverables, are: evidence, contracting, front-end collaboration, organization, information management and tool development. The specific topics that require additional attention and development would be as reported by validation interviews: more evidence collection, more on information management, technologies and metrics.

Further developing the following topics will provide a more robust execution model:

9. **Evidence:** develop quantifiable evidence to form a stronger business case and provide further discussion around management and workforce buy-in.
10. **Contracting:** provide recommendations around contracting strategies and requirements and potential levels of implementation considering contracting constraints, such as construction-only contracting.
11. **Front-End Collaboration:** provide more detailed recommendations on how to achieve front-end construction consideration and collaboration between construction, engineering, and procurement.
12. **Organization:** provide definition around project roles & responsibilities, potentially through the use of a RACI diagram. Provide recommendations around successful organization structures and reporting hierarchies for enhanced work packaging.
13. **Information Management**: provide more details around the requirements of information management and document control for successful work packaging. Further discuss the importance of system integration.
14. **Technologies:** due to the great impact they can have on work packaging success, provide analysis of and recommendations around current technologies, such as modeling, virtual packaging, and material management systems.
15. **Metrics:** provide metrics to measure work face planning implementation success and the impact on projects.
16. **Tool Development:** develop additional tools to support the implementation of work packaging, such as CWPs, EWPs and IWPs samples and templates.

APPENDICES

Appendix A. Expert interviews questionnaire

CII/COAA RT 272 Interview Guide for Work Packaging for FEED and DE

Interview Guide for Engineering

Interviewee: _____ Date: _____

Company: _____ Time: _____

Location: _____ Duration: _____

Company General Characteristics

1. Please describe your position within the company as well as your experience

_____

2. What is your Industry focus?

   - Chemical,
   - Residential,
   - Commercial Buildings,
   - Energy,
   - Others

3. What is your main engineering activity?

   - Front-End Engineering Designs (FEED)
   - Detailed Engineering
   - Procurement
   - Construction

4. What are your construction engineering services?

_____

5. Where are your projects based?

_____

6. What is the main engineering contract type of your projects? (Check all that apply)

   - Lump Sum Contract
   - Unit Price Contract
   - Cost Plus Contract
   - Others

_____

7. What are your typical project drivers?
   - o Cost
   - o Quality
   - o Time to market (schedule)
   - o Others

8. Please describe your experience with work packaging?

Front-End Engineering Designs (FEED)

All questions below concern the FEED phase

9. Please give an overview of your current process of Engineering Work Packaging?

10. For how long has this current form of Engineering Work Packaging (EWP) process been implemented?

11. Before utilizing this process of work packaging, what was used for planning?

12. What does drive the sequence of EWPs and procurement?

13. Please characterize what you consider a "workable engineering package":

14. Please describe your work packaging process during the FEED
    a. Define what is an Engineering Work Packages (EWP)
    b. Describe what is a Construction Work Package (CWP)
    c. Characterize the relationship between a CWP and a EWP?

15. Please describe your CWP/ EWP boundary development process :

---

16. Who does the EWP boundaries development?

---

17. Please describe any differences between the EWP process and the WBS process at this stage?

---

18. Please describe your EWPs progress monitoring process?

---

19. When do you start considering construction in the engineering? in FEED?

---

20. Is there any formal process to get Construction involved in the engineering phase?
    - o Yes
    - o No

    Explain briefly any that apply,

---

21. Do you see any benefits for the construction side to be involved in this process?
    - o Yes
    - o No

    Explain briefly any that apply,

---

22. What Information tools support the process?
    Please define

23. What areas of improvement for Engineering Work Packaging have been identified for FEED?

24. What were the key difficulties associated with the Engineering work packaging process during the FEED?

25. What do you consider are the success factors for work packaging in the FEED process?

Detailed Engineering development process

26. Please describe your process of developing the detailed engineering documents?

27. Who is involved in developing the detailed Engineering documents?

28. Please describe your work packaging process during the Detailed Engineering phase

29. Please describe any existing **updating process of EWPs and CWPs**

30. Is the construction side involved in the detailed engineering process?
    - Yes
    - No

If yes, explain how this is,

31. How is the construction feedback to the Engineering side?
    - Formal
    - Informal

Explain briefly any that apply,

32. Do you see any benefits for the construction side to be involved in this process?
    - Yes
    - No

Explain briefly any that apply,

33. How do you tie procurement into your EWP planning?

34. Do you use any incentives or payment milestones for triggering payments?

35. How do you make sure that Procurement and Engineering are consistent with the Installation sequence?

36. How do you tie vendor data required by dates for your EWPs?

37. What does a complete CWP contain? (Check all that apply)

- Safety requirements
- EWP s
- Schedule
- Budget (labor hours/cost/productivity)
- Environmental requirements
- Quality requirements
- Special resource requirements
- Other

Comments:

---

38. What does a complete EWP contain (Check all that apply)

- Scope of work with document list
- Drawings (e.g., general arrangement and equipment installation)
- Installation and materials specifications
- Vendor data (e.g., equipment O&M manuals)
- Bill of Materials
- Lists (e.g., line lists and equipment lists)
- Additional pertinent information to support (e.g., permitting studies)
- Other

Comments:

39. For how long has this current form of Engineering Work Packaging process been implemented?

40. What opportunities for Engineering Work Packaging have been identified for the Detailed Engineering?

41. What were the key difficulties associated with the Engineering work packaging process during the Detailed Engineering?

42. What do you consider are the success factors for work packaging in the Detailed Engineering?

43. What is your involvement in the IWPs?

44. Any thoughts related to the construction phase?

Company Organization and Work Packaging functional capabilities

45. Does the company enforce Work Packaging practices or does the project team determine its application?

46. Do you have a champion for the new work packaging process?
    - Yes
    - No

    If yes, please describe his/her responsibilities

47. Do you have a Work Packaging planner? Please describe the relationship between the Engineering manager and the Work Packaging planner?

48. Are there any new positions that were created specifically for the current work packaging process?
    - Yes
    - No

    If yes, please describe,

49. Is there any specific work packaging team?
    - Yes
    - No

    If yes, please describe,

50. What cultural changes resulted from the new work packaging process implementation?

Contracts

51. The contracts' role in enhancing the work packaging process for Engineering?

52. What contract language do you recommend for enhancing work packaging procedures?

53. Perceived needs and recommendations to be addressed in contracts for work packaging process improvement?

---

54. What do you think about progressing and scheduling by EWPs?

Appendix B. Interview Guide for Work Packaging during FEED and Detailed Engineering

Hello! The joint Construction Industry Institute and Construction Owners Association of Alberta industry research team on Advanced Work Packaging would like to request your help in assessing current planning procedures for engineering and construction work packages during the design stage of capital projects.

Specifically, research team would like your assistance through an interview covering topics including work processes during FEED and Detailed Engineering, organizational capabilities, and contractual approaches (see following page).

Interviews are expected to last about one hour. Depending on the knowledge of the interviewee, the interviewer may request contact with different people in your organization to allow a thorough understanding of your procedures.

Interviews will be conducted by a University of Texas at Austin researcher. All information provided will be kept confidential; reports and summary materials generated from the interviews will not contain identifiable information. You will be given the chance to review any final report materials from your company to assure that all confidential and/or identifying information has been removed.

This research will help the research team (1) identify the current range of practices during design and (2) improve recommendations to advance the industry. We thank you in advance for your support.

Contact Information:

Olfa Hamdi

T: +1 (512) 669 8436

E: olfa.hamdi@utexas.edu

Interview Guide:

Please find below the main points that we will go through during the interview:

1. Background and Company General Characteristics

- Your position, your experience overview, company's activities and services

2. Front-End Engineering Designs (FEED)

- Overview of your current work packaging process for Engineering during the FEED phase
- Engineering Work Packaging (EWP) and Construction Work Packaging (CWP) characterization
    - Definition, content and relationship
- Differences with the WBS process
- Construction involvement within the process
- Specific Information tools supporting the work packaging process
- Perceived benefits and challenges

3. Detailed Engineering development process

- Overview of your current work packaging process during the Detailed Engineering phase
- Typical content of a "complete" EWP, CWP at this stage
- Construction involvement within the process
- Perceived benefits and challenges
- Identified areas of improvement

4. Company Organization and Work Packaging functional capabilities

- Changes occurring as a consequence for engineering work packaging process implementation:
    - Organizational changes (new positions dedicated to work packaging process (a champion, a WorkFace planner etc.)
    - Cultural changes

5. Contracts

- The contracts' role in enhancing the work packaging process for Engineering
- Perceived needs and recommendations to be addressed in contracts for work packaging process

Appendix C. Expert interviews write-ups

CII/COAA Research Team 272

Advanced Work Packaging

Expert Interviews

Summer/Fall 2012

Introduction

This document contains nineteen expert interviews collected by the CII Research Team 272 Advanced Work Packaging. These studies informed the team on the work packaging practices being implemented within the construction industry today and provided insights during the development of the execution model for work packaging especially during the Front End phase. The projects and companies represent a range of industrial and commercial construction sectors, including power, oil and gas projects, in addition to a range of work packaging maturity (see figure below).

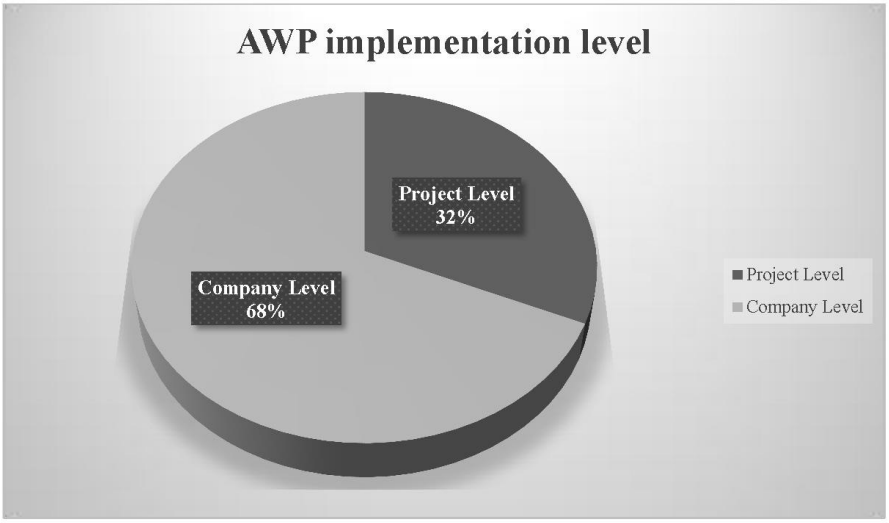


FIGURE 1 AWP IMPLEMENTATION LEVEL

Figure 0. Expert interviews – discussed AWP level of implementation per interview

The identities of the companies presented in this document have been made anonymous as well as the identity of interviewed experts. The following tables 1 and 2 present details of the experts' interviews (company coding, sector, company type and experts positions).

Each interview presented based on the case common group of information as well as very specific set of data. Each formal write-up contains the following themes:

- Company Overview

- Project Description
- Work Packaging Processes, including previous and current Advanced Work Packaging planning efforts, design, content, issuance etc.
- Organization
- Contracts
- Communication between Engineering and Construction
- Advanced Work Packaging Performance, including benefits and challenges

Interviews Summary Tables

TABLE 1 DETAIL OF EXPERT INTERVIEWS

Company Coding	Sector	Company Type	Expert function
A	Energy (Oil & Gas)	EPC	Vice president
B	Energy (electric utilities)	Owner	Project Engineering Supervisor
C	Energy (nuclear)	Owner	Manager of nuclear projects
D	Industrial (refinery)	EPC	Project Manager
D	Energy	EPC	Consultant - WFP planner
D	Industrial (Refinery)	EPC	deputy construction manage
E	Energy (Oil & Gas)	Owner	Construction WF manager
F	Energy (Oil & Gas)	Consulting	Consultant WFP
G	Energy (Oil & Gas)	EPC	Construction manager
H	Energy (Oil & Gas)	Owner	Project controls and infrastructure oil sands
I	Energy (Power)	Owner	Engineering plant planning lead
I	Energy (Power)	Owner	Project manager-process and tool expert.
J	Energy (Oil & gas)	EPC	WFP manager
K	Energy (Oil & Gas)	EPC	Chief Operating office - VP Project Management Office
L	Energy (Gas producer)	Owner	Construction and construction engineering manager
E	Energy (Oil & Gas)	Owner	Project manager
E	Energy (Oil & Gas)	owner	Construction manager
M	Energy (Oil & Gas)	EPC	System and integration manager
N	Various construction sectors	Consulting	Director

TABLE 2 AWP IMPLEMENTATION LEVEL PER INTERVIEW

	Project Level Interviews	Company Level interviews
Expert Interview 1		X
Expert Interview 2		X
Expert Interview 3		X
Expert Interview 4	X	
Expert Interview 5	X	
Expert Interview 6	X	
Expert Interview 7		X
Expert Interview 8		X
Expert Interview 9	X	
Expert Interview 10		X
Expert Interview 11		X
Expert Interview 12		X
Expert Interview 13		X
Expert Interview 14		X
Expert Interview 15		X
Expert Interview 16		X
Expert Interview 17	X	
Expert Interview 18	X	
Expert Interview 19		X

Expert Interviews

EXPERT INTERVIEW 1

Company overview

Company A is a large Australian provider of professional services to the energy, resource, and complex process industries. Company A is an EPC company. It provides also construction management services. The company has about 40 000 employees. Typically, projects are on a reimbursable basis.

Expert characteristics

Background and professional experience

Expert 1 is vice president of construction services for the United States and Canada. He has 21 years of experience in the construction industry.

Work Packaging Processes

Level of implementation:

Company level	X
Project level	

Overview of the work packaging process

The first step in the FEED phase is developing a plan containing Construction Work Areas and then Construction Work Packages. Construction Work Areas are geographically based packages but can also be a process unit too where a construction work package is a portion of that unit. At this stage of the project, the amount of change is huge so the company finds that one of the easiest ways to break work down is to consider areas. Conceptually, this process is an old one. The company has been doing it manually for years but now, the company is using a software program to help them manage and control the work packaging system. The company has been looking for software applications to make the

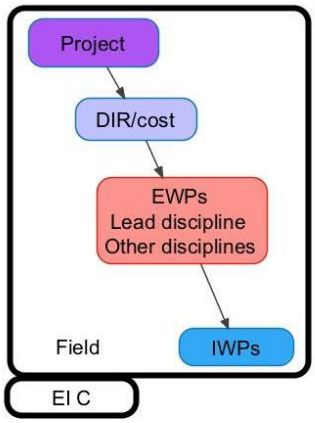


FIGURE 3 AWP HIERARCHY COMPANY C

Communication between the construction side and the engineering side

- There are core holders meetings between each design point: between the 30% and 60% and between the 60% and the 90%. The objective of such meetings is to help flash out the engineering work with more details as well as review the performed design work. The presence in these meetings is compulsory.
- Installers are involved in the 30% phase which helps taking into consideration construction issues at a very early stage
- For the construction people involved within these formal meetings, there is a set of formal deliverables that they should provide after the review process. There is a special review guideline to help the construction people get involved at early stages. This review guideline contains a list of questions that should be asked during the review process.

Organizational perspective

There is a dedicated team of people working to ensure the success of the work packaging process; in fact, there are work packages planners, material specialists, project managers, engineers and designers. There is a dedicated project control organization within the project management office that takes care of tracking materials and vendor data.

process more efficient. The company has bought a software development company used for the management aspect of construction and more specifically the work packaging process.

Engineering work packages

A workable engineering package is a package with parameters defined by the construction side on how to get work done. It does contain engineering drawings by discipline. Disciplines in work packages are classified to minor disciplines and major disciplines.

The EWP break down is consistent with the CWP breakdown. EWPs feed CWPs with drawings and other requirements.

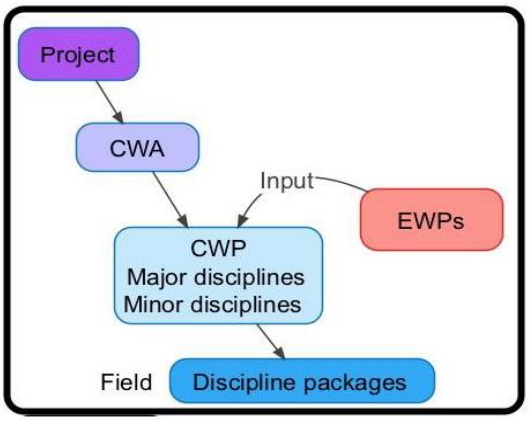


FIGURE 2 AWP HIERARCHY COMPANY A

In the construction section of the WBS, CWP breakdown is consistent with the WBS. WBS for engineering and procurement can be different from the work packaging scale. The company tries as best as possible to request drawings by CWPs developed to maintain coherence. Expert 1 thinks that if the request is not done externally to Engineering, the Engineering won't take the initiative to follow work packaging breakdown structure.

CWP Content

- Safety requirements
- EWPs (drawings)
- Schedule
- Environmental requirements

- Quality requirements

No budget related documents are included in CWPs.

Communication between the construction side and the engineering side

Formal process of involvement of construction people: as soon as the plan is ready containing construction work areas and construction work packages, the FEED team sends this plan to the engineering side to start working with. This plan is mainly produced by people from the Construction side. There is also a budget allocated to have construction people involved during the FEED and DE phases to develop formal and informal constructability information, input to scheduling people, input to budgeting team.

Organizational perspective

Technology was the driver for any organizational changes in the company relating to work packaging. Indeed, the company used to have a CPM scheduler separate from other management functions while now the company is getting a specialized team working on work packaging and using the integrated scheduling and packaging software too. A packaging engineer is mainly focusing on keeping coherent the packaging process and sequencing. Expert 1 estimates that 15 people working on work packaging manually could be replaced by one person working on the same amount of work packaging but using technology to execute work.

Cultural changes

Packaging engineers do not understand computer based work packaging method. Finding skilled people (with capacities of understanding the work packaging process and using the technological tool) is a challenging fact for the company.

Contracts

Expert 1 believes that the contracting strategy needs to be driven by the work packaging plan. The work packaging plan defines how the project will be designed and how it will be done. So based on this, the contracting strategy should follow the work packaging plan.

Disciplines in work packages are classified to minor disciplines and major disciplines. This means that the work packaging process enables organizing the work into pieces of work that defines easily sub-contractors.

Summary of Benefits and Challenges

TABLE 3 SUMMARY OF BENEFITS AND CHALLENGES

Benefits	
• Success factors: - consider WP as a FEED product	
Reduced man hours by assembling packages	
Easily enhanced by technology	
Challenges	
• Getting Engineering work toward work packaging structure	Expert 1 believes that if the work packaging structure is not followed and adopted by both construction and engineering side, the process will be considered as failing with much trouble.
• Getting construction people on board early enough in the project	Construction people do not understand the need to this process.
• Budget for the construction people involvement	Getting people from the Construction side to early stages has a cost that should be addressed and allocated from the beginning
• The Input clear definition to each stakeholder	The process has been completed through the company experience with the system. Defining what is really needed as input to different stakeholders can be challenging especially if there is no well documented and established process

EXPERT INTERVIEW 2

Company overview

Company B is an American electric utilities holding company. It is one of the largest producers of electricity in the United States. Company B serves 4.3 million customers and serves a large territory with 27,000 miles of distribution lines. Company B is an owner that does EPCM too.

Expert characteristics

Background and professional experience

Expert 2 has 32 years of experience within Company B in the engineering field. Expert 2 has four years of experience in Advanced Work Packaging.

Work Packaging Processes

Level of implementation:

Company level	**X**
Project level	

Overview of the work packaging process

The company does as an owner a lot of the engineering. Expert 2 mentions that his company rarely outsources engineering.

FEED:

The front end effort starts with the conceptual design stage which leads to delivering the project actual roadmap that contains the scope defined, the project definition and the implementation milestones. Expert 2 mentions that there is emphasis on construction during the front end through scope, technicality and engineering or preliminary design. He also mentions that the schedule id the priority in this stage. The schedule production is correlated to developing the contracting strategy that takes into consideration about 10 years' time period.

There is no formal language set up around engineering work packages. However, is considered as workable engineering packages parts of the schedule and are based on the Work Breakdown Structure (WBS).

An Engineering work package would be a set of drawings that feed construction work packages (CWP). CWPs are initially defined by area. The schedule is then monitored through regular schedule reviews and monthly meetings.

Expert 2 mentions that the FEED phase is a deliverable based approach. 3D models are input to the CWPs.

The project technology plan is also defined during Front End.

Execution phase:

The execution phase starts with a level 3 engineering and level 3 construction execution.

Communication between the construction side and the engineering side

Construction people get involved in the Front End phase through the process of preparing some documents that are required during early stages. Those documents are: the contracting plan, the crane study and 3D models. The group construction services interacts then with the Front End team through regular meetings and the involvement of the Project manager and site superintendent.

During Detailed Engineering, disciplines design being an internal procedures get construction feedback. Change is discussed between both sides.

Cultural changes

No information available as this process as implemented in the company has been in place for a period long enough to be established from a cultural perspective.

Contracts

CWPs are associated with bid processes. Expert 2 thinks that somebody needs to make sure the contracting strategy is being understood by all stakeholders. He also thinks that for work packaging, incentives should be introduced.

Summary of Benefits and Challenges

TABLE 4 SUMMARY OF BENEFITS AND CHALLENGES

Benefits	
• Improved execution • Improved constructability and field execution	
Challenges	
• Continuous evolution of the process	Projects evolve very quickly and change is the rule not the exception. This is being a challenge noticed by expert 2 in his company with their existing work packaging system.
• Different delivery methods	Construction projects are very diverse and involve many stakeholders. Different contractors can have different delivery methods. This induce inconsistencies in the working relationship from an owner perspective.
• Defining priority	Expert 2 mentions that his company first driver is not profit. However, the company has a very robust technical solution requirements and regulations which is not the most common scenario. Experts 2 mentions that projects differences put an emphasis on cost that should not be sacrificed.

EXPERT INTERVIEW 3

Company overview

Company C is a Detroit-based diversified energy company involved in the development and management of energy-related businesses and services nationwide. The company provides the following services: electric / gas utilities, power / industrial Projects, gas storage & pipelines, coal & related services, unconventional gas and energy trading. The company was incorporated in 1995. Company C owns power plants in Alabama, California, Illinois, and Michigan; 95.5% of the company's generating capacity comes from power plants in Michigan. The interview is related to the company's nuclear generation construction facilities. The company is a full EPC. The company's work is based totally in the US. The company's projects are regulatory driven: 0 MPV and 0 payback. Reliability and equivalent performance are also drivers of projects.

Expert characteristics

Background and professional experience

Expert 3 is currently a manager of nuclear projects and modification process. He has been doing this type of work since 1982. He has joined company C in 1990 and is responsible for design and work packages preparation as well as execution of activities in the field. The direct employees for expert 3 are project managers. The other tasks like cost estimating or design are contracted.

Work Packaging Processes

Level of implementation:

Company level	X
Project level	

Overview of the work packaging process

The design process within the company is based on three main stages or phases: the 30% phase, the 60% phase and the 90% phase.

The 30% stage (design point):

The main objective of this phase is to develop an initial Construction Work Packaging Plan within the Design Input Record (DIR). It is a sort of a conceptual walk down which provides input to the Engineering work Packages (EWPs). The Design Input Record (DIR), which is basically a design box, contains typically the specifications and regulations, the margins and the design parameters.

The following items and aspects of the project are defined during this phase:

- Project sponsors
- Impacts / program / risk management
- Implementation perspective: assessment of the risk generation and constructability
- Contingency plan development
- Vendors and supply chain contracts
- Initial Work Breakdown Structure (WBS) driven by work activities and disciplines

Installers, work packages planners are involved during this early stage and are considered as key stakeholders for the success of the process.

The Design Input Records are mainly divided by cost. The smallest DIR is about 1000$.

The Construction Work Packaging initial plan provides the big picture of the project with a relatively advanced level of detail in engineering and procurement.

The 60% stage (design point):

The 60% stage output is focused on Engineering Work Packages. The following items / aspects of the project are developed during this phase:

- Scope of work
- Impact on procedures, calculations etc...
- Review of the engineering and risk plan of the 30% phase
- Review of the contingency plan of the 30% phase
- Work on the installation perspective: big picture of the type of support structure
- WBS template and project identification process

Engineering work packages are also meant to evaluate the feasibility of a specific task.

The 90% stage (design point):

At this stage, most of the design is already done. The constructability and main tenability aspect of the project are further enhanced. At this level, the lowest level of work packaging is ready to be issued to the field. The field installers are ready to go to work.

What is an EWP?

A typical EWP contains 25 to 50 drawings and specifications. Its structure is very formal and has a standard format. An EWP typically contains:

- Scope of work section
- General impact plan
- List of documents: plans, drawings, design calculations etc...
- Separate documentation issued for needed support
- Change evaluation

Each EWP has a lead discipline but can contain other disciplines. EWPs can be labeled as multi-disciplined packages with one lead discipline.

Installation Work Packages (IWPs) are one or two weeks size with a minimum of one week required. IWPs feeds the construction work packages and contain basically construction sketches needed to execute the fieldwork.

Tracking work packages

There is a work packaging management system that is tracking the list of all activities on a weekly basis. There are also different types of meetings and reviewing processes to track the project progress status:

- Weekly schedule review meetings focused on the engineering work
- Weekly schedule accountability meetings
- Monthly float assessment based on updated schedules after meetings

The main tool used is Primavera, which can generate reports. Expert 3 thinks that the company is making a maximum use of the software and that the software is very suited to the work packaging process. MS Project was not chosen because it lacks of functionalities to control cost for big organizational capacities exceeding 1.5 M$.

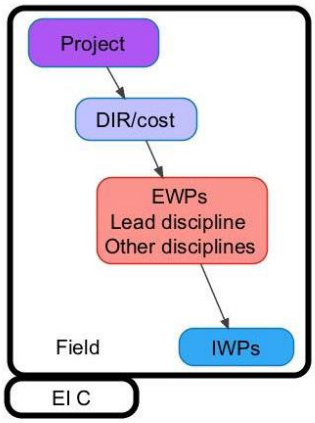


FIGURE 3 AWP HIERARCHY COMPANY C

Communication between the construction side and the engineering side

- There are core holders meetings between each design point: between the 30% and 60% and between the 60% and the 90%. The objective of such meetings is to help flash out the engineering work with more details as well as review the performed design work. The presence in these meetings is compulsory.
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Organizational perspective

There is a dedicated team of people working to ensure the success of the work packaging process; in fact, there are work packages planners, material specialists, project managers, engineers and designers. There is a dedicated project control organization within the project management office that takes care of tracking materials and vendor data.

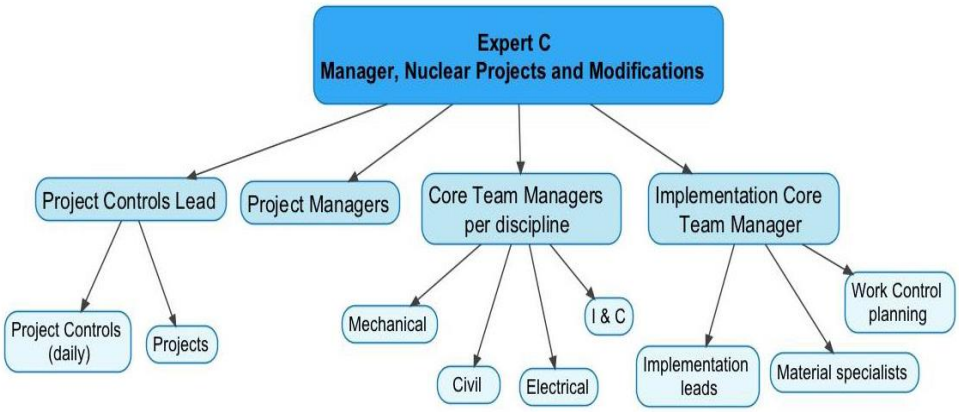


FIGURE 4 ORGANIZATIONAL HIERARCHY COMPANY C

Cultural changes

People from the maintenance department were moved to the engineering and construction organization when the company decided to go for a new business case. People showed reluctance toward this big change. Project managers' positions were created. This required engineers to move to a project management positions which requires much more different skills. This was considered as a big cultural shift that presented the challenge of defining clearly the position responsibilities and requirements.

There were job familiarization trainings to educate people on new positions' goals and tasks.

Company C has updated its work packaging system two years ago to push the process more up-front and get people more involved at earlier stages. There is a contract management training that is provided to project managers; this helped increase the protection of the company liability and the success of the execution of work packaging process. In addition to this, the company lawyers are also engineers. This enhances the company security and consistency of its contracts.

Summary of Benefits and Challenges

TABLE 5 SUMMARY OF BENEFITS AND CHALLENGES

Benefits	
Provides structure	
Good way to make engineering scheduled	
• Measure in advance	Company C has noticed that 94% of scheduled work was completed comparing to a 50% completion five years ago.
Certified project management	
Challenges	
Inconsistency in execution	
• Having price contract based on alliance to the best value for the dollar	More fixed prices will be better

EXPERT INTERVIEW 4

Company overview

Company D is an experienced USA-based EPC firm offering services engineering, procurement, construction and maintenance, as well as project management services on a global basis. The company works in wide range of sectors, including oil and gas, chemicals and petrochemicals, commercial and institutional, government services, life sciences, manufacturing, microelectronics, mining, power, telecommunications, and infrastructure. The company operates in five main divisions: Oil & Gas, Industrial & Infrastructure, Government, Global Services and Power with over 100 years of operating experience.

Expert characteristics

Background and professional experience

Expert 4 is currently an EPC project manager. He has been with company D for about 22 years. Expert 4 has more than 40 years of experience; he has spent about 10 years on refinery work, 10 years on chemical plants work and 20 years on power work. 90% of expert 4 experience is based in the United States.

Experience with work packaging

Expert 4 has little experience with work packaging before the current project.

Work Packaging Processes

Level of implementation:

Company level	
Project level	**X**

Project description

Sector: Industrial

Sub-Sector: Oil & Gas

Project Type: Renovation and green field work - refinery

Project Location: Eastern U.S.

Contracting Strategy: Lump sum

Construction Duration: 3 years and a half

Two refineries constitute the project: a 2008 refinery and a 2012 refinery. Project 4 has then two construction sections: a green field section and a revamp section. For each section of work, construction work is assigned by contractor and by period. This led to different contracts as shown by the following figure:

FIGURE 5 PROJECT CONTRACTUAL STRUCTURE

The construction phase started during the mid-phase at about 25% of completed detailed engineering. Company D decided to implement a specific work packaging system shaped to the project characteristics aiming to support the contracting schedule. Expert 4 was not involved during the scope of the Front-End Engineering Design (FEED). No specific work packaging system was used during the Front-End Engineering Design phase. The organization of the project is described by the figure above. In fact, there are three plants or refinery areas: East, West and Greenfield. For each plant, different units are defined primarily by area. For each unit, different disciplines are considered by project phase and cost structure. This structure is the basis for the work packaging boundary definition. Expert 4 said that this project is very probably the most complex project he has seen during his 40-year career.

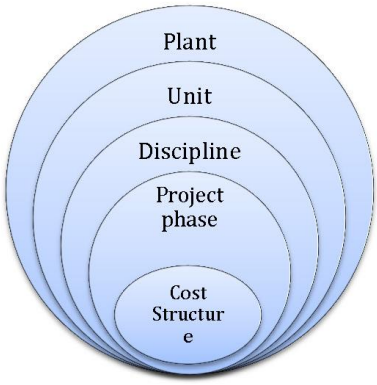


FIGURE 6 ORGANIZATION OF THE STUDIED PROJECT COMPANY D

Work Packaging practice description

Work packaging is currently being implemented in this project specifically. The team did not have prior experience with work packaging. In addition to being the project manager. Expert 4 is the pioneer for the work packaging implementation of this project. No special training was done for implementation purpose. Guiding documents were provided to discipline leads.

Construction Work Packages (CWPs): design and content

Construction work packages (CWPs) are developed for **each unit and by Engineering Discipline**. The estimated number of construction work packages for the project is 800. Those CWPs provide a list of drawings to make up the scope of work, a list of reference and supporting documents and other supplementary instructions when needed. It was mentioned that CWPs were not intended to replace job cards or provide a detailed narrative of work instructions. The size of a CWP depends on the unit. A small CWP contains typically 2 to 3 drawings.

Global documents are all documents that are related to specifications and standards and are communicated to all contractors. A CWP does not contain safety requirements. Safety requirements are in a global document. A CWP typically contains the following documents:

- Scope of work
- Engineering documents (drawings and narratives by discipline)
- Schedule by unit and by discipline (the detailed schedule is developed by the contractor which

can be the same company or a third party)

- Vendor documents
- Materials

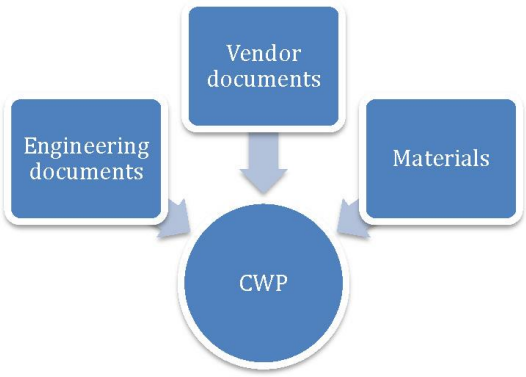


FIGURE 7 CWP CONTENT

CWP issuance

Each discipline provides two types of input in the CWP Management system to generate a CWP: the originator's form and the discipline drawings.

The originator's form containing the work characteristics, the unit number, the document type and the phase. The Project Document and Data Management (PDDM) people then upload this form to the company Provisioning Object Library (POL). The CWP management system administrator exports then the form from the POL to the CWP Management system. The CWP manager uploads also the discipline drawings in the CWP management system that generates finally a **CWP Documents List** reviewed and edited by each Discipline (Material check is done by each discipline). Finally, the construction/field PDDM prints CWP documents and issue to the contractor a complete CWP containing specific deliverables and narratives related to the discipline.

Updating CWPs

A CWP is revised when new documents are added or when documents are deleted. Some CWPs are revised up to 7 times. The updating process made through the document control system in which is monitored every document in different CWPs.

The figure below shows the revision steps of a CWP.

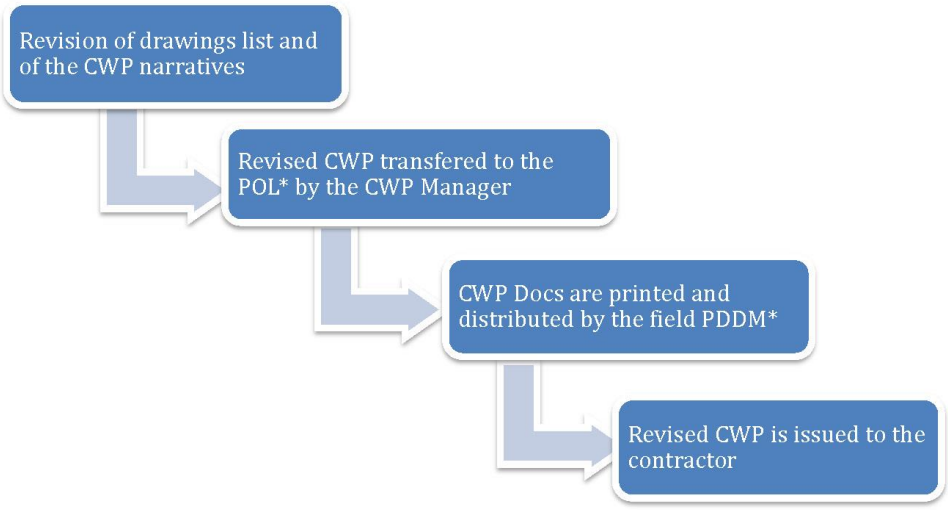


FIGURE 8 CWP REVISION PROCESS

*Field PDDM: Project Document and Data Management

*POL: Provisioning Object Library

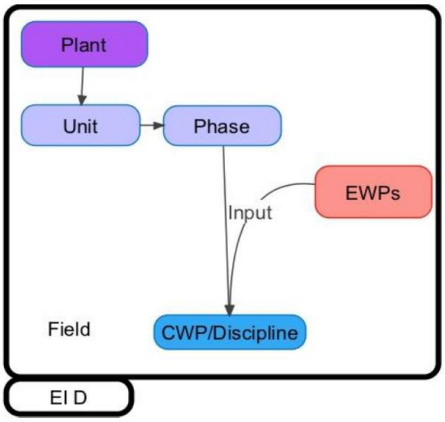


FIGURE 9 AWP HIERARCHY COMPANY D

Construction and Engineering interactions

During early stages of design, construction people were involved in a formal and an informal way. In fact, they were involved in the constructability review process, in reviewing the first design

developments and later in the construction review. Formal meeting involving the construction and procurement side are scheduled in a regular basis. There is a heavy informal exchange between the construction side and the engineering side.

Functional capabilities and cultural change

No official change in the organization and the functional capabilities of the project team. However, some other changes were noticed: some people working in the agency ended working full time on managing the access database for work packaging to make sure every document was counted for. This was predictable because of the increasing number of packages and documents with the increasing complexity of the project over time. 4 to 5 people were full time on this process of database management for about 150 engineers and designers involved.

Company D implements different work packaging systems on different projects. Depending on the project characteristics, the work packaging system is customized to meet the project needs and specific challenges. Below some feedback from different involved people in the process:

Feedback 1: in the beginning of the implementation process, engineers showed resistance and did not like the concept. They thought this is meant to facilitate construction side work and complicate their work. Getting people on board was a challenge in the first stages of the process implementation.

Feedback 2: for this project, a significant number of people expressed satisfaction of the work packaging process in resolving the complexity of the project. They recognized its value in increasing communication between different stakeholders and in decreasing different types of conflicts. Involved people think that this project would be unmanageable without this work packaging system because of its increasing complexity with time.

Summary of Benefits and Challenges

TABLE 6 SUMMARY OF BENEFITS AND CHALLENGES

Benefits	
• Facilitated detailed engineering disciplines	For engineering disciplines that requires a high level of detail (e.g. Mechanical engineering), the work packaging system helped engineers identify areas easily and communicate information well
• Better alignment between construction and Engineering	Communication was enhanced between construction and engineering sides and helped overcome the complexity of the project organization
• Reduced engineering & construction cost	Engineering costs were optimized by the reduction of rework and the control of the CWPs
• Contracts by work packaging	The contractual team recognized the value of aligning the contracts with the work packaging system. The contracts were structured around CWPs. This helped push the implementation and face the early resistance of stakeholders
Challenges	
• Stakeholders buy-in (cultural challenge)	In the beginning of the implementation process, engineers showed resistance and did not like the concept. They thought this is meant to facilitate construction side work and complicate their work
• Following the changing scope	The scope changing from 2010 turnaround and 2012 turnaround was challenging. Even though the adaptation process was challenging, expert 4 thinks that the work packaging system was the key to overcoming this challenge

• Different levels of detail	The work packaging system might be less useful for some engineering disciplines that did not require by nature a high complexity to overcome (e.g. piping)
• Experience and training	Expert 4 thinks that the team will be performing much better in using the work packaging system in the future. He recognizes the importance of experience and training in this success of the process.

EXPERT INTERVIEW 5

Company overview

Same as previous (Company D).

Interviewed expert 5 is working for company D subsidiary in Canada.

Expert characteristics

Background and professional experience

Expert 5 is currently a WorkFace Planning (WFP) manager hired as a consultant by Company D. Expert 5 has a project management background (he was also a superintendent before becoming a WFP manager). He has also experience in the Quality Control and Materials.

Experience with work packaging

Expert 5 is a WorkFace planning manager. He is member of the Construction Owners Association of Alberta (COAA) and is currently a consultant in the construction industry in Canada working on advising companies about the implementation of WFP in their projects. Expert 5 is currently working on a 1 billion dollar project, heavily using modularization process. He has spent one year in the home office in Calgary working on the first design phase of the project and he will be on site for the construction phase where he is involved in the right implementation continuity of the work packaging process carried on from the FEED phase.

Work Packaging Processes

Level of implementation:

Company level	
Project level	X

Project description

Sector: Industrial

Sub-Sector: Oil & Gas

Project Type: 3rd generation modularization project

Project Location: Canada **Contracting Strategy:** Cost plus

Work Packaging practice description

For this project, the FEED phase lasts one year. During this phase, the conceptual engineering work delivers the list of Construction Work Packages (CWPs). The process of CWP formation is described by the following figure.

FIGURE 10 WORK PACKAGING STRUCTURE

The basic breakdown is by area. Each area is divided to a certain number of Engineering Work Packages (EWPs) based on an areas too. Typically, these EWPs are modules that are delineated into Construction Work Packages (CWPs) which are discipline based. Each CWP is also divided into Field Installation Work packages (IWPs) which are specifically built around disciplines of each CWP. The COAA model is the basis for this work packaging breakdown structure.

The area breakdown, EWPs and CWPs breakdown is done by a joint team between the general contractor and the client as well as a number of leads from different discipline contractors. This process is done during the FEED phase.

The engineering side is expected to deliver EWPs and the list of CWPs.

Each contractor uses the CWPs and the scope of work to develop its own IWPs. The whole process is audited by the general contractor represented by Expert 5 who is the WorkFace Planning consultant and manager.

Sizes

An EWP is an individual module (e.g. pipe module).

A CWP is based on one discipline (a typical CWP contains about 15 IWPs)

An IWP is equivalent to trade crew, which is equal to one shift done by one size crew. One shift is about 10 days and one size crew is equivalent to 10 men.

FEED deliverables

During the FEED phase are developed:

- A preliminary Project Execution Plan (P.E.P); this plan will be refined as the project is more detailed.
- A preliminary Construction Execution Plan (C.E.P); this plan will be refined as the project is more detailed.
- The list of EWPs
- The list of CWPs
- The list of IWPs
- A high level schedule that is updated as soon as a change occurs and more detail is available

Content

EWP

- Scope of work
- Drawings
- Design specifications
- Vendor data
- Bills of materials

CWP

- Safety requirements
- Environmental and quality requirements
- Level-three schedule
- Material

- Drawings
- WorkFace plan
- A mention that IWPs will be used with expectations

Construction and Engineering interactions

During the FEED phase (which lasted 1 year for this project), people from the construction side are heavily involved. Expert 5 considers this as a critical success factor for the project performance as well as the work packaging system implementation. The following people work together during the FEED phase to produce the best work structure and constructability plan for the project:

- A construction managers from Company D (general contractor)
- An early work & module manger (Company D)
- A WFP manager (Company D)
- A general superintendent (Company D)
- One owner construction manager (client)
- One owner project manager (client)
- Construction engineers (those involved during the construction phase; some of them are present on field)

This team is expected to take part in the modules reviews, be very involved in the scheduling and planning process by attending meetings and generating reports. Expert 5 says that this heavy involvement of the construction people from a very early stage is uncommon within the Canadian construction industry. The specificity of this process is that all levels of supervisors are involved from a very early stage. Expert 5 thinks that not having the field level of supervision involved is a big obstacle in front of the successful implementation of work packaging. In fact, one of the most important factors for the successful implementation of work packaging is the buy-in of all levels of supervision of the process.

Contracts

Expert 5 thinks that contracts should be organized around CWPs. He also thinks that a first agreement on the terms of use of WFP should be defined at the very beginning of the project.

Summary of Benefits and Challenges

TABLE 7 SUMMARY OF BENEFITS AND CHALLENGES

Benefits	
• Saved budgetary cost • More organized work / faster • Reduced man power -> safer work • Enhanced productivity	Rework has been eliminated and work is more organized. This leads to the reduction of man power which also makes the work safer and the morale better for a better productivity. Expert 5 thinks that up to 25% of direct labor cost can be saved with proper implementation of WFP.
• Optimized scaffolding system	One of the first reasons WFP was invented by COAA is to overcome the difficulties related to scaffolding in terms of productivity, safety and feasibility. WFP mixed with modularization.
• Improved morale and good atmosphere of work	Mainly because of the 100% buy-in of the field level management people, the work atmosphere was very good and was generated by the smooth work and the clarity of the process for each party.
Challenges (reasons for failure of WFP)	
• Lack of senior management buy-in	The current implementation methods of WFP do not take into consideration the involvement of the field supervisors and managers in the FEED. This is one of the main reasons for the lack of buy-in which is a considerable obstacle in front of the execution of WFP in the construction phase. The FEED process has to be driven up to the superintendent to get the buy-in by experience and to ensure that the field execution of the work packaging process is healthy.
• Lack of education	Different stakeholders don't understand WFP

	process in its enhanced version going from the FEED to the construction phase. Once IWPs are issued in field, the beginning of their usage is slowed down by the lack of education. This is also an obstacle for the communication between people. Expert 5 recommends bringing the construction people involved in the scheduling process too. He thinks that the management staff should keep in mind always making stakeholders move as a team and make regular audit of the process.
• Quality and price of work packaging training and consulting	Expert 5 thinks that a lot of people see WFP and work packaging techniques are a money grab and they sell this service for companies at very high prices. The implementation method is not always the best suited for the company characteristics. Expert 5 thinks that WFP and any type of work packaging should be shaped and modified based on the needs and characteristics of the company. For instance, when lean techniques and practices are already in place, WFP is not implemented the same way as for a company that is not using lean. When Lean Six Sigma is already in place, the WFP should be shaped to take into consideration the communication and work flow process.
• Re-allocation of planners to the field -> distracted WorkFace planners	Since WorkFace planners are known to handle the overall project execution well by knowing the structure of work and the sequencing, there is a tendency in a lot of project to take planners away from the planning department and push them on field to do more supervision and field work.

	Expert 5 thinks that this is one of the reasons of failure of projects work packaging implementation.

EXPERT INTERVIEW 6

Company overview

Same as previous (Company D)

Expert characteristics

Background and professional experience

Expert 6 is a Deputy Construction manager. He has a BS in civil engineering.

Work Packaging Processes

Level of implementation:

Company level	
Project level	**X**

Overview of the work packaging process

The project is a modernization of a refinery. Considering the project different phases, the implementation of WFP started at about 30% of the construction completion.

The general contractor (Company D) introduced the process to the owner during the construction phase to address certain emerging issues that have been observed during execution.

The objective was to:

1- Provide a further level of scoping as it became difficult to manage disciplines with high level and big CWPs. (unit -> CWA -> CWP (10 000hour of labor)
   The increasing level of complexity raised a discussion about using WorkFace Planning even at a late stage of the project.
2- Manage crew by crew: for disciplines that were working on the same area and with the big number areas to cover, the need to manage the execution and scheduling on field was urgent

Process description

The process was started initially in one of the company offices in Canada with consideration of the FEED as a primary stage for WFP implementation. The implementation of WFP in this particular project started by a one day training with support from the south Carolina office that has been experiencing WFP for years.

Expert 6 thinks that work packaging has always been done in construction projects but that WorkFace Planning brings the advantage of formulizing the process and bringing order to it.

Previously, the process was as follows:

Construction Work Areas (CWAs) are divided into CWPs that are each about 10 000 labor hours (can go to 20 000 or 30 000 = several weeks of work). These CWPs include schedule and budget and per WBS, they were divided by prime discipline to get issued to the field crews.

When WFP was introduced, the work was still divided by area but a second level of breakout was added. In fact, sub-areas were defined and packages for sub-areas contained: budget, schedule, quality and specifications. The process was designed to make sure no interfaces were existing between packages as well as reliable and interfaces free scaffolding planning.

Field Implementation Work Packages contained scaffolding planning. Progress in work performed was monitored on a weekly basis. Typically, packages were ready 3 weeks before the execution. 3D models are used. In the new packaging systems, model shots and 3D graphics were included in the packages issued to the field. This was not happening before and seems to have created a better communication with people in the field as well as a boosted motivation to execute things right. Work packages were also linked together.

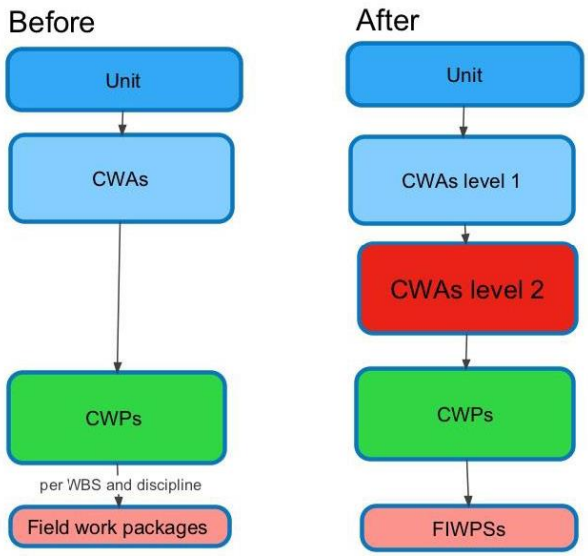


FIGURE 11AWP STRUCTURE

Communication between the construction side and the engineering side

For this project, construction people were not involved in the FEED. The late implementation of WFP is one of the reasons; previous work packaging system was not creating the linkage between construction people and the engineering side at an early stage.

Organizational perspective

1- Integrators: a team of 10 integrators was in place to build packages; these integrators are usually people from the field (foremen, general foremen and estimators). They have to be able to communicate with people in the field with the same language as they are used to. Integrators have skills in planning but are not planners.

2- A specific team was dedicated to the work packaging system; basic tools were provided (computers, equipment) and additional effort was done to bring all involved people in one place under meetings. It was noticed that some discussion happens just when people meet face to face; this helped raise issues and discipline conflict early. For instance, electricians and pipers did discuss issues during the meetings in the office, something that they never did in the field.

Expert 6 points out the benefit of having formal meetings in an office for the field people; this environment (around office tables) seems to bring discussion that is more serious. Expert 6 believes also that somebody dedicated full time to the implementation and coordination of WFP should be in place.

3- There were people dedicated to produce educating documents (interfaces people) explaining the process of work, the communication between people

Cultural changes

Passionate leadership was a key factor to push the process. Resistance to change is even bigger when the project is already in the field execution phase. Leadership commitment to the process success is a key to get the buy-in of lower levels of supervision, which are still key

Contracts

Contracts help address the issue of conflict of interests between construction people and engineers; originally, field engineers were the one building CWPs. The new process seems to take their work from them; this creates a feeling of frustration among them.

First, a tension was perceived but soon, it disappeared because printing drawings from packages and discussing them with integrators brought clearer vision of the work and showed early detection of errors, which reduced rework.

Summary of Benefits and Challenges

TABLE 8 SUMMARY OF BENEFITS AND CHALLENGES

Benefits	
Material management: improved efficiency of material delivery	
Built team work	
• Tools to track the numerous work packages	The process of tracking set helped have a better control of the increasing number of documents
Challenges	
• Resistance to change	Introducing a new concept in a working project was not very well received. Especially field personnel showed resistance and pushed back because a part of the work

	was already done. The process of education was challenging and foremen showed different levels of penetration and buy-in
• Weak material tracking system	There was no control on how to track materials on field and manage them. General foremen were bringing as much material as they can to the working site which created congestion because of disciplines shared areas. Since areas are smaller, the specific need to the success of the process was to bring the right material at the right time in the right area. This was not monitored and was a challenging task
• WFP is very interdependent process	Convincing people in the warehouse was a challenging task. The WFP didn't work very well; indeed, the process creates a lot of interdependencies and to be successful, it requires everybody to do things right. This is not the case currently.
• Knowledge management	One of the weaknesses of the way the industry is doing business is the re-allocation of experienced people. First, this can be seen by giving an experienced team different projects not similar to those they have gained experience in. Second, people who usually do the FEED work are re-allocated once they accomplish their work in the FEED phase. In fact, they are sent to work on another FEED phase of another project. Both issues contribute to the loss of efficiency and skills gained during a specific project as well as the loss of the knowledge gained on a project from its very early stages to benefit the construction phase;

EXPERT INTERVIEW 7

Company overview

Company E is a Canadian integrated energy company based in Calgary, Alberta. It specializes in production of synthetic crude from oil sands. Company E has activities outside Canada (Syria, Libya etc...). The company major volume of activities is in Canada. The company is also one of the largest Canadian retailers of petroleum products

Expert characteristics

Background and professional experience

Expert 7 is a construction Work Packaging Manager. She has joined company E 5 years ago right after her graduation with a master in engineering. In order to implement WorkFace Planning through the company, expert 7 has conducted an internal audit of the company to develop WFP front over.

Work Packaging Processes

Level of implementation:

Company level	**X**
Project level	

Overview of the work packaging process

The company has developed a theoretical set of work packaging procedures that are fully documented and periodically reviewed and updated. The company has an objective of reaching the full implementation of this developed model. The following description of the work packaging system within company E is the current implemented work packaging system and not the theoretical one.

"3 CWPs and IFCs ready before you start construction."

Bidding process and work packaging:

The process contains 3 parts:

1- Scoping & Study

2- DBM: Design Basis Memorandum

3- EDS: Engineering, design, Specification

Construction managers are in all 3 phases involved

Construction managers are in the 3rd phase and sometimes in the second.

After bidding, the IFB (Issue For Bid) is issued and the owner asks the contractor for budget and schedule. Once the contractor awarded, the owner works with the GC to complete CWPs. The final input: EWP, IFC, regulatory requirements, materials. A complete CWP will be issued for construction not for biding. Once the contract engaged, IFC and CWPs are developed. Then, IWP release plan is required from each contractor. The owner makes sure that there are enough engineers to create a backlog and that engineering is making progress to be able to continue.

CWP:

Are developed based on: area, contracting strategy, systems and modularization.

The scope of CWPs is large with several considerations and factors included. Construction managers, project managers and contract strategy managers work together to define CWPs.

The owner develops the CWP-EWP log and brings it to the E-P house to work with them on it. The same log is also taken to the project controls people and put into schedule. The objective is to see and determine construction requirements needed by engineers.

In case P.C decides that a CWP is not feasible, they will ask to break it down. CWPs are multi-disciplined. Company E does contract based on CWPs not EWPs.

EWP:

EWPs are identified with engineers. There is no typical size for them.

The criterion for an EWP to be validated is: whether or not this package can be completed within the time frame to be sent out for bid.

CWP Table of Content
1.0 SCOPE OF WORK
2.0 CWP REFERENCE LIST
3.0 ENGINEERING INFORMATION
4.0 MANPOWER

5.0 MATERIALS
6.0 ENVIRONMENTAL, HEALTH & SAFETY
7.0 QUALITY
8.0 REGULATORY APPROVALS AND PERMITS
9.0 SUB-CONTRACTORS
10.0 VENDOR SUPPORT
11.0 RIGGING STUDIES
12.0 SCAFFOLDING
13.0 CONSTRUCTION EQUIPMENT, TOOLS AND CONSUMABLES
14.0 WASTE MANAGEMENT
15.0 RISK
16.0 WORKFACE PLANNING
17.0 PROJECT CONTROLS
18.0 TURNOVER DOCUMENTS
19.0 CONTACT LIST(S)

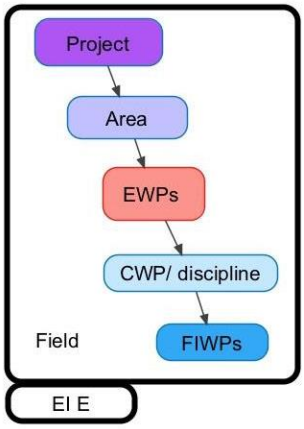


FIGURE 12AWP STRUCTURE

Communication between the construction side and the engineering side

Construction planners are typically part of project controls but within company E, they plan construction execution with consideration of constructability issues, labor and management considerations.

Construction managers come in before execution and work on the plan path of construction as well as on CWP definition.

Tracking engineering work

This is done using engineering and project productivity curves. These curves show how engineers are going to perform which helps assess more accurately reasonable and suitable speed of work and schedule.

The way this is monitored is based on

- A regular reporting required by company E (owner) for each engineering stakeholder (internal or external).
- Generate regularly a report from data to see where are CWPs and EWPs
- Use indicators such as "squat check": see EWP before issuing IWPs (develop more)
- So cross functional
- If the value is not seen, people don't participate
- Matter of education; can be done but there is not enough time to change management

Cultural changes

Resistance to change is noticed but with education, it can be overcome.

Contracts

Because there are so many players in construction projects that are all involved in the work packaging process, you need to define contractually requirements for each player in order for the model to be successful once implemented. Vendors should be provided with needed info based on contracts too. A very deep level of detail is needed in contracts to avoid confusion and time & productivity loss because of legal issues. Current contracts are not detailed enough and can easily bring confusion to the work execution.

Summary of Benefits and Challenges

TABLE 9SUMMARY OF BENEFITS AND CHALLENGES

Benefits "IF WELL DONE"
Scope of work well defined
owner has provided the contract with as much info as needed with respect of construction

Measurement of the packages	
Success factors: - better control - New to people, there is potential Regulatory requirements are well detected and brought to surface	
Challenges	
• Poor job of change management	It has been a struggle within the company to move to construction work packages and the whole work packaging system. Expert 7 thinks that the company could make things easier by creating a better change management plan (like introducing training sessions, targeting key people, work on buy-in etc.)
• Expanded functions of the WF planner	CWP manager is a coordinator whose work is different from the WFP planner. Expert 7 is not only a CWP manager but also WFP expert which makes her very involved in the WFP planning process from the front end stage. This is a challenging combined position. Expert 7 thinks that a WFP planner is also required from the GC in addition to the one from the owner. At least 2 WF planners are required for this type of project and contracting strategy
• So many functions	So many functions → big coordination efforts that are not always well met
• Number of simultaneously involved stakeholders	14 stakeholders are involved in coordinating a CWP; managing this number of stakeholders is a challenge especially when it comes to collecting info from all of them.

"Still a battle..."

EXPERT INTERVIEW 8

Company overview

Company F is a consultancy company started by expert 8 six years ago to provide the following services:

- Facilitate WorkFace Planning Implementation
- Facilitate the transition to WFP within the organization from a cultural perspective
- Develop procedures shaped to each company, assign the needed people to implement the process and apply those procedures
- The company has a generic set of procedures that are the basis of the implementation for each company. Those sets are customized to the need and characteristics of the company and the project.
- Typically, the implementation is done on a project level rather than on a companywide level. However, this is not the rule. Expert 8 mentioned that some companies requested procedures to be applied to the company level without specific application to a particular project.

Projects for which expert 8 has been facilitating WFP implementation range from large projects of 20 billion dollars to small projects of 10 million dollars.

Expert characteristics

Background and professional experience

Expert 8 has been a foremen, and a superintendent and is now a consultant. He started his own company six years ago. Expert 8 had been a productivity specialist for 10 years. He has joined COAA committee in 2004 and has been involved mainly in projects in Canada and in a smaller number of projects in the United States (2 in the US out of 15 total).

Work Packaging Processes

Level of implementation:

Company level	**X**
Project level	**X**

Overview of the work packaging process

Expert 8 thinks that a Construction Work Package is a translation of an Engineering Work Package to the construction phase. Both are area based and are defined after Construction Work Areas specified. Ideally, the scope of an EWP is very close to a CWP. The difference is in the content where drawings from the EWPs added to other information related to material, equipment, site conditions etc... become a CWP. The Installation Work Packages breakdown is done after EWPs are received from the engineering side. This model can be adjusted especially when it comes to the size of packages.

IWP

The basic outline of IWPs is developed in the engineering office by WFP planners and other knowledgeable people. EWP are developed at the latest 3 weeks before the actual work. After that, WF planners get those packages and translates those IWPs. IWPs are being prepared 2 to 3 weeks before the actual work in the field starts. The preparation follows this general steps:

- 1st week: EWPs cut into IWPs
- 2nd week: constraint identification and elimination
- 3rd week: IWP scheduling

Expert 8 has been involved with some examples of engineering companies that have adopted WFP system to their procedures in order to meet the WFP system at the construction side. The majority of engineering companies have not done this effort yet. However, in both cases, the traditional way of improving the process is to invite people from the construction side to participate in the early stage. However, Expert 8 insists on the fact that the way things should be done is the opposite way where **construction people lead the process of the sequence and early scope development.** This idea is coherent with the development of the path of construction per COAA model. Within this model, stakeholders together led by construction people develop at an early stage the following sequences:

1. The construction sequence
2. Then, the engineering sequence
3. and finally the sequence of procurement

Expert 8 thinks that engineering people are enthusiastic once they experience early collaboration with construction people coming to them. Expert 8 recommends that specific people from the construction side are assigned early enough to go get in touch with engineering. The current

problem comes from the fact that usually construction people are assigned after engineering are done with the early scope. This problem can resolved by either having a project management side involved through the whole project cycle or by assigning a consultant that plays the role of the construction side and fills the gap that might be created by late construction people assigned. Thus, expert 8 thinks that DBB system is not convenient for the work packaging process. This is usually the case for schools, hospitals and other public work.

Tracking engineering work

Expert 8 thinks this is a sensitive subject for engineering. When an engineering work package is developed, the number of drawings needed should be easily estimated. EWPs can be considered as performance indicators and can create then a source of conflict between owners and engineering.

Cultural changes

Previously, the focal point for engineering companies was the client & the customer. Now, with the work packaging system, they have two targets: the owner and the construction side. To be successful, they have to satisfy both sides which creates more communication that leads to better cooperation. There still challenges to realize this new vision since contractually speaking, engineers can keep being distant and not very involved with the construction side.

Organizational perspective

Positions within companies implementing g WorkFace planning change from two perspectives: either by modification of responsibilities or by creation of new positions.

For example, 3D modellers become in communication with the construction side much more often (sometimes, on a full time basis). Traditionally, this is not the case. Expert 8 thinks that the key liaison between engineering and construction resides in connecting 3D modellers to construction people.

Contracts

The same way safety has gone through to get improved should be taken for work packaging. Safety improved because of the contractual requirements that owners initiated requiring trainings, Companies started improving safety because they were told to and awareness was increased mainly

thanks to the contractual requirements. Contracts largely affect the behavior and the work environment and methods. This is why expert 8 thinks this is a crucial part of the implementation.

In an order of priority and importance, expert 8 things that the following items are the most important for the success of the work packaging implementation in the industry:

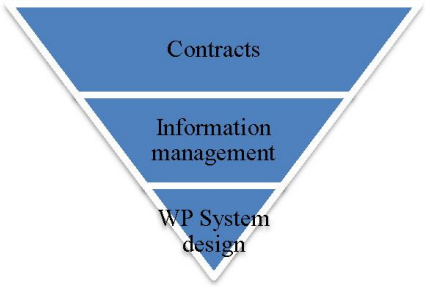


FIGURE 13 INFORMATION HIERARCHY

Summary of Benefits and Challenges

TABLE 10 SUMMARY OF BENEFITS AND CHALLENGES

Benefits	
1. Information management	Work packaging documents are usually communicated in pdf. format as well as a hard copy from engineering to construction. Work packaging pushes the exchange of advanced models (3D models). Work packaging from FEED helps address the question of how to get information from Engineering to Procurement and from Engineering to Construction
2. Material management	The mature model of WorkFace planning is full electronic. Reaching this level would enhance the productivity of construction projects
Challenges	

Lack of consideration of construction in early stages is a weakness of the WorkFace planning system and should be enhanced
WorkFace Planning is still in early stages of implementation in the industry…so results are not very well documented. WFP applied to engineering is a rare practice.
Engineering think systems Procurement think commodities Construction think all and geographically Different thinking complicated by culture

EXPERT INTERVIEW 9

Company overview

Company G construction services are engineering, construction management, consulting, and continuous presence or maintenance services and plant operations and turnaround services. 2011 revenues of over $10 billion. Company G uses COAA model for WorkFace Planning compiled to an internal tool.

Business view: expert 9 said that Company G is a relationship based company. It believes that the better job done for a current client, the increased chance are of repeating business. Company G invests in keeping satisfying customers (which explains investment in work packaging), because they think that it's cheaper to make an investment to provide a quality deliverable to a client that will cause him to come back rather than having to go out and compete and win for new work with other customers that strictly are looking at lowest cost. Company G is not a transactional company and its business model does not believe in transactional projects where there are a lot of lump sum contracts with a lot of risks. Expert 9 said "I think that through our involvement with CII and COAA over the years, we've learned to be a responsible service company to satisfy the needs of owners company"

Expert characteristics

Background and professional experience

Expert 9 is a construction manager with Company G. He has been with Company G for 25 years. He has worked for three construction contractors prior to joining company G. Expert 9 has 40 years of experience. He has worked in Alaska (pipeline project) within the scheduling and planning department of the company. He has also worked in manufacturing and process plants construction. He has held positions like construction engineer, superintendent, site manager, consultant building manager and finally program manager.

Expert 9 has been experiencing the majority of sides of construction projects.

Work Packaging Processes

Level of implementation:

Company level	
Project level	**X**

Project description

Sector: Industrial

Sub-Sector: Oil & Gas

Project Type: derivative units

Project Location: Gulf Coast

Contracting Strategy: reimbursable

Construction Duration: FEED: 2 years

Expert 9 is ccurrently working in a FEED phase on a major project on the Gulf Coast. The project team did a site selection study last fall (fall 2011), and completed the conceptual phase or the project definition package earlier this spring and then early summer commenced the front end engineering design phase for a major chemical plant expansion on the Gulf Coast. Expert 9 is engaged with part of a design discipline and construction planning for the project. The project consists of two derivatives units at a site that the client owns. And basically, expert 9 is doing the construction sequence planning, the constructability reviews, and the front end planning to be able to provide the definition during the engineering phase that will eventually result in, during the execution phase, the full implementation of the development of field installation work packages.

This project is a billion dollar project. At the time of the interview (September 2012), the company has completed +/- 25% of the estimate total install cost (TIC) that includes include engineering effort, materials procurement, as well as construction direct labor and indirect costs.

Overview of the work packaging process

Work packaging by company G varies from client to client, but generally, construction planning is an integral part of the design team. When the team moves into the front-end engineering design, there will be either a dedicated full-time or part-time resource as part of the project team to accommodate construction planning.

How is engineering work packaged during the feed phase?

Expert 9 works with the layout designers as far as the way the process flows is developing. Work is done collaboratively on the constructability aspects, implementation and design aspects that will enhance the ability for execution in the field when it's being constructed and then identification of sources of off-site preassembly. The FEED team uses CII tool PPMOF that allows us to do preassemblies, prefabrication and modernization of facilities, the tool also helps define the work that can be packaged for offsite. When the manufactured equipment components are identified, the team identifies the critical nature of the components tied with the length of time it takes to get accomplished. Then, an overall sequence plan is developed to identify when the equipment needs to be purchased in order to meet the field installation date. The typical size of a component (e.g. a vessel) is approximately 25 feet diameter by 200 foot long and weigh approximately 300 tons.

Work is packaged but not initially. In the design and development, in the feed, the team starts with identifying what are the critical components and when does engineering need to buy those components. Then once this done, the construction sequence is developed with the groupings (packaging). After that, the team identifies and helps engineering build their work packages. The basis for engineering work packages breakdown structure is areas defined from the 3D model.

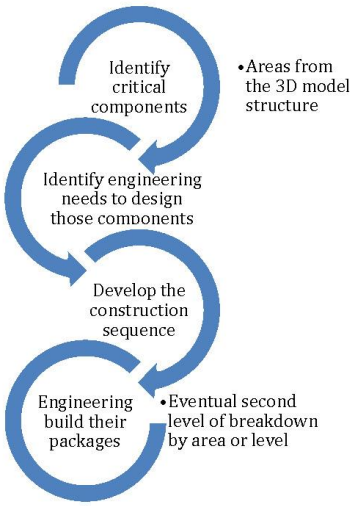


FIGURE 14 WORK PACKAGING PROCESS

An engineering work package definition

It falls into the category of a **discipline**: site development activities, civil activities which would include any piling, any foundations, followed by your structural steel, structures, fixed equipment and rotating equipment packages, pipe racks, various ways for piping and or electrical, piping components, electrical installations and instrumentation installations. The level of breakdown can be narrowed by area or level. For example, with civil, we can have piling pile caps, spread footings and area paving are components that fall within a given area. Likewise with piping, we have underground sewer piping, underground process piping, underground utility piping, and then above ground the utility and process as well large and small bores and then special alloys. Consequently, it further breaks down into the different categories there.

What about the detailed engineering phase?

A lot of owners at the stage do the **"gated process".** The gated process allows owners to validate their feasibility study estimates, their conceptual phase estimates and continue to refine that for shareholders of the board of directors' approval allowing to move into the next phase. Aat the end of this feed phase, company G delivers a plus or minus ten percent estimate for this project which includes engineering cost for the detailed design as well as the material cost for the detailed design as

well as construction and startup phase along with any construction costs for labor and materials and supervision management.

Communication between the construction side and the engineering side

The involvement of construction people will increase in the detailed engineering phase. After framing up the activities that will be necessary during the detailed engineering as well as the field execution phase in order to support the plus or minus ten percent estimate.

Expert 9 said: "the key thing that we've learned in 2001, the president of our company said we owe it to our clients to do constructability for them whether or not we construct the project or not, and one of the main reasons is that if you're familiar with the influence curve the earlier that you have involvement with the construction planning in a project, the greater influence you'll have in bringing value to the project."

- FEED package
- Formal schedule reviews with discipline
- Formal scheduled workshops for alignment with health and safety and environmental groups, the quality control/quality assurance groups, the operability/maintainability philosophies
- risk mitigation and identification workshop
- confirmed mechanical completion and commissioning alignment workshop
- constructability and sequence review essentially by discipline= engineering work package definition

-> direct and mitigated approach of involvement

Information tools

For example, the mechanical group has a mechanical equipment list. It's also a spreadsheet that is allowed to be linked into your purchasing database that is also linked to the company instrument indexes (tagging process). Those indexes are set during the feed phase so that you can implement it during the detailed design phase. Essentially that's one of the key tools that are used with work phase planning in which the company merges into the modeling software. The company owns ConstructSim, a software allowing to prepackage during the planning process and help manage the project.

Cultural changes

No information.

Organizational perspective

- "Work phase planning manager" early during the detail design phase where only the basic footprint for the 3D model, equipment arrangements, and a certain percent of the critical lines are available.
- Workplace planning manager: In the construction planning phase, he is sets up in the model to facilitate future detail planning and implementation.

Contracts

Work packaging process by discipline plays a key role in how we can enhance the overall effectiveness of the project by selectively carving out those portions of the work that have adequate definition to obtain a **competitively bid lump sum** proposal. Especially contractors who perform in that manner.

Summary of Benefits and Challenges

TABLE 11 SUMMARY OF BENEFITS AND CHALLENGES

Benefits	
Anticipated cost addressed properly	One of the key things to do during these early phases is avert any unanticipated costs or out of sequence work or surprises that were not anticipated when the budget is presented at the end of this phase. The key task for construction involvement within the process is that to continue to be able to increase accuracy for your TIC predictability cost.
Facilitated discussion	
Work packaging process by discipline plays a key role in how we can enhance the overall effectiveness of the project by selectively carving out those portions of the work that have adequate definition to obtain a competitively bid lump sum proposal. Especially contractors	

who perform in that manner.	
Challenges	
Owners were reluctant to pay any more	
challenges with getting census with all of the parties about a preferred method to go and so a key part of it is the ability to be resonant and communicate with the disciplines to better communicate " We have a lot of studies that we do here internally as far as a collaborative discussion so that's a team group so that we can get consensus for perhaps a decision that needs to be made but you want to have a consensus with everybody so that they understand why we arrived at the proper consensus."	

EXPERT INTERVIEW 10

Company overview

Company H is an oil/natural gas company that is primarily positioned in oil. The company main projects are based in Canada. No global projects. Engineering and Procurement are done externally however construction management is not delegated out. Expert 10 thinks that projects are mainly driven by quality and schedule. Expert 10 states also that "the company is the lowest capital efficiency out of all our peers, so that being said we have a cost competitive advantage at this point."

Expert characteristics

Background and professional experience

Expert 10 is a project controls expert (Director - Project Controls & Infrastructure Oil sands). He has been working with Company H for 18 years. He has been working for the last five years on oil sand projects while reporting to the central services group. Expert 10 has accompanied the company through the different merging phases that the company has lived.

Work Packaging Processes

Level of implementation:

Company level	**X**
Project level	

Overview of the work packaging process from a project controls perspective

The project controls side is responsible for tying the work breakdown structure with the cost breakdown structure. Company H does not do engineering work packages. The base is man-hours and it's driven by schedule. Company H has a manufacturing approach to its business. A good portion of the design base is a template. The engineering houses create engineering work packages based on the company work break down structure, which is consistent with areas defined early in the project.

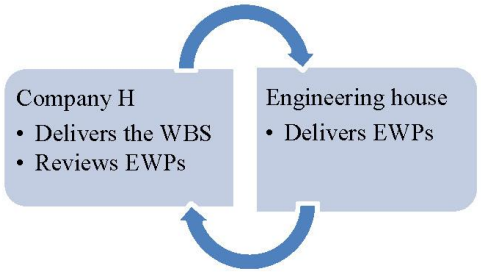


FIGURE 15ENGINEERING AND CONSTRUCTION RELATIONSHIP

Project controls gets involved on several different fronts. One is developing an integrated schedule for the EPCM because the EPs and CM are generally separate. So the objective is to be able to integrate that because each function is creating its own schedule and it has to be able to apply to the higher schedule. Once PC has the high level schedule line, it starts breaking it down into the work packages.

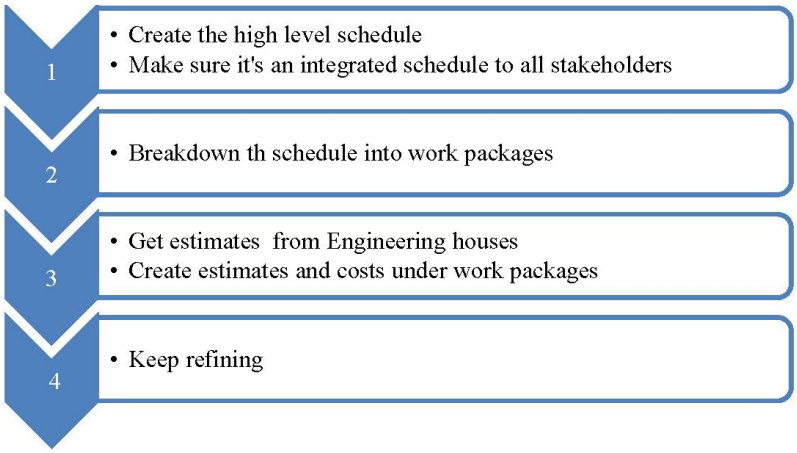


FIGURE 16 WORK PACKAGING PROCESS

Company H construction work packages, in the numbering process, essentially goes from the asset the phase of the project to the area of the project to the discipline to the sub-discipline. So, it's a linear process. Each individual package will be specific to this area.

FEED Phase:

Essentially, a project needs to be sanctioned at the FEED phase. Initially, the company performs what is considered a "scoping initiative" where the economics of a project is determined. Company H has to provide enough scoping information at a high level because it is a 50/50 partnership with another company on its major projects. Satisfying internal hurdles of both companies should be met during this early stage of scoping. From the time the scope meets both companies' needs, it gets sanctioned and the detailed engineering stage is initiated.

Detailed Engineering prior to construction:

Prior to the construction phase starting, the engineering house of company H has to have a sufficient amount of work packages out so that the work will be continuous without gaps. So, the construction team gets involved 6 months ahead of the actual first pile. Central services provide the earth works: any of the dirt moving, any of the gravel aggregate in order to create the initial base and access to the project is done by a separate group. Then all the mechanicals, piling, structural, and stuff get to start working. This process is coordinated by the construction management team.

Communication between the construction side and the engineering side

The construction team gets involved 6 months ahead of the actual first pile. Central services provide the earth works: any of the dirt moving, any of the gravel aggregate in order to create the initial base and access to the project is done by a separate group. Then all the mechanicals, piling, structural, and stuff get to start working. This process is coordinated by the construction management team.

Cultural perspective

- When it comes to the construction itself, company H doesn't just employ one large constructor to build plants. It hires multiple small contractors, so 50 people or less, to do the work. Expert 10 thinks that with the high demand of the oil stands for work force and all that, it's easier to plug and play one small contractor than it is to replace one large one if you have an issue. This plays a role in shaping the way company H executes work and links construction to engineering.
- Company H has been working towards aligning its previous business culture across the company with new standardized processes. So this a cultural change that has been recent since the formation of the new merging two years ago. New standards and alignment procedures were developed which was perceived as conflicting with the company very entrepreneurial spirit. To

address this change, company H is working towards on the standardization and formalization of 80% of the work, leaving 20% of "freedom" of creativity to managers and supervisors. Expert 10 says " They don't like the large corporate beasts that these companies create"
Example: "Let's say the company is considering a game changing opportunity within building a facility, but it deviates from our standard model. What we'll do is create and monitor that game changing opportunity off to the site and see how it will fit and be incorporated into future bases that we build. One of the other things within our corporate model is that we don't build full scale projects at any given time and they're not full capacity. We build at incremental phases to bring us up to the capacity the reservoir can meet as we always get new information telling if we can go larger or not. This gives us a lot more flexibility. This ties back to the entrepreneurial 20% that we always want to maintain to ensure flexibility. We also can take advantage of game changing opportunities at a minutes notice, but we prefer to do them off to the side rather than impact our manufacturing approach at any given time."

Organizational perspective

The "scoping initiate" during FEED is done by a project management team called a **PMT**. It's fed information from the outset from several people. It's a cooperative event involving many people including reservoir geologist and business analytics and others. All of it is combined to holistically put together a picture that is a reasonable representation of what they expect the outcome will be.

No people from the construction side are involved during this stage. Representatives from the engineering side are involved. The project management team is the one representing construction in this phase. After the design is 50 or 60 % done, the construction management team is brought to verify and check estimates and materials.

Relationship of project controls and other functions

Essentially project controls is functionally linked to the project management team. The project management team oversees the management of the entire project from the engineering to the close out phase. Inside company H, Project Controls has tried three different models. One is to embed project controls to the team. One is to keep the functional to the outside and the third is working with a matrix. Because of the current logistical situation of company H now, project controls team was moved outside of the business unit into the central services group. So now they work for the entire company and not just specifically for one particular asset, which

takes a little bit of the control away from the project management team and gives more of a third party objective viewpoint. FEED project management team to be able to execute the job efficiently and effectively and at the same time, the intent of the project controls within company H is to be able to provide an objective third party look at how the project management team is doing.

This change took place in 2007 after an experienced failure in project controls. Pimavera used and in the future, Primavera cost management tools and construction management tools will be used more heavily.

Contracts

No available information.

Summary of Benefits and Challenges

TABLE 12 SUMMARY OF BENEFITS AND CHALLENGES

Benefits	
Emphasis on Project Controls critical role to the implementation of AWP during FEED and DE	
Challenges	
Incompatibility of Work packaging numbering structure with other companies	Inconsistencies create disagreements with partnerships because of the different ways of project controls. Expert 10 thinks there is a tradeoff between how much standardization and how much it takes away from one's corporate flexibility to execute projects.
Conflict in partnerships	

EXPERT INTERVIEWS 11 and 12

Company overview

Company I is American multinational conglomerate corporation. The company operates through four segments: Energy, Technology Infrastructure, Capital Finance and Consumer & Industrial. The company is a top 10 fortune 500 company in the US and is top 5 in world by gross revenue

The company has a considerable experience in power generation. Interviews were conducted for interview 11 and 12 with people from the power generation division of the company.

Expert Characteristics

Two experts were present for this interview. They are respectively Engineering plant planning lead and Project manager-process and tool expert.

Work Packaging Processes description

- Sub contract out to engineering firm
- Tasks are based on division of responsibility based on project contract
- Work packaging is left up to the engineering company
  - The scope is defined by company I
- Company I products and equipment comes out of the energy group
  - There is a project engineering group that is used to support equipment
  - The need is defined based on that scope develop deliverables
  - All shipped to site
  - Develop specifications
- Engineering review of the plant as a whole, systems and equipment
  - Review plant to mitigate the risk to company
  - A list of the deliverables is made
  - Assign by system to discipline
  - There are risk reviews for each discipline
  - Assign system to particular discipline

- Work breakdown structure followed
- Division of responsibility
    - The scope can be extended beyond power generating
- Usually hires architect engineers or hires partners that hire architect engineers
- Project engineering group
    - coordinate with partners
        - Technical and management do interviews

- Project management group
- Construction management group
    - Have entire group that just does project scheduling
        - Works between everyone
        - Ideally all work together
        - Done within first month project is released
- Construction management companies that are hired
- Main responsibility is project-engineering group for engineering
- Power plant schedule has same milestones that are dictated by contract
- Level 1 schedule
    - Major milestones and deliverables to meet those
    - Material to site level 1
    - Level 1, 2, 3 and 4
    - 4-individual preforming specific task as overall work flow

Challenges

1. Challenges of aligning engineering task to schedule
    - Matching up time it takes to do engineering and get to supplier to design them to stay on schedule
    - Purchase order must be placed way early to get documentation so construction team can work on their level 3 schedule. However, in many cases we cannot do that until they have details of actual design
    - Schedules alignment – misalignment is frequent

- There is a critical need to share information's-deliverables

2. Milestones are not well developed or not developed at all
   - Many times don't say when milestone needs to be done, dictated in contract
   - Have a template of level 2 schedules for each major milestone
     - -Typical task needed to be accomplish to meet milestone
   - Where can we combine task, where can we eliminate tasks- (their job)

Recommendations

- Lessons learned system
  - If usual situation encountered
  - Try to address and then assign to discipline engineers in business
- Success factors that make engineering successful
  - People
  - Upfront synchronized schedule
  - Good experience and savvy people
  - Clear delineation of scope
  - Clear division of responsibility for each scope
- People who are making scope at first level:
  - people who make scope are on ITO –inquiry to order (sales)
  - Have engineering group that interfaces with their engineering group
  - Turnover meeting once receiving contract
  - sales to execution
- Weekly meetings
- Meeting face to face regularly can help resolve conflict
  - Follow-up with minutes and actions
  - Practices have been in place for a very long time

Summary

- Company has been around a really long time

- They know what works and what does not

- They realize it's important to learn from the past-especially in contraction industry. "Lessons Learned" are important to capture.

- Communication is key
  - Experienced people
  - "People People People"

EXPERT INTERVIEW 13

Company overview

Company J is the Oil & Gas division of a bigger company. Company J was recently acquired by another company. Company J is specialized in sand oil construction and provides oil field services. Company J is based in Canada. Its projects are mainly on a cost reimbursable basis. All the indirect work is on a lump sum basis. The typical driver for the projects is schedule for WorkFace Planning.

Expert characteristics

Background and professional experience

Expert 17 is a currently a WorkFace Planning manager. Expert 17 graduated from one of the European universities majoring in Construction Planning and Management and joined company J right after graduation. Expert 17 has been involved with WorkFace Planning for the last 5 years after being involved in field from the civil work side.

Work Packaging Processes

Level of implementation:

Company level	**X**
Project level	

Overview of the work packaging process

Company J has adopted the WorkFace Planning per COAA definition and has shaped it to the company characteristics. The main difference in the WFP model use within Company J is that they skipped the Construction Work Packages (CWPs). Expert 17 said that "within the company, they have learnt that developing CWP per COAA model is a waste of time and energy and that getting directly for IWPs is more efficient". CWPs were found to add to the timeline even though the scope of work is already known. This induced duplicated efforts in both CWPs and IWPs.

The company schedule is by IWP.

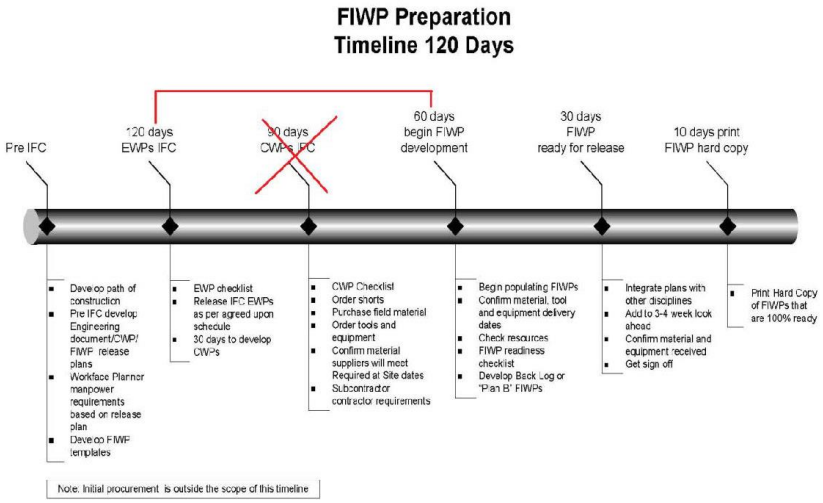


FIGURE 17WORK PACKAGING TIMELINE

Source: http://www.coaa.ab.ca/Portals/0/Downloads/BP%20Productivity/FIWP%20Timeline.pdf

One of the first deliverables within this process is the EWP release plan that involves the construction side. This release plan is developed typically at an early stage and is based on the preliminary design.

EWP

The size of an EWP depends on the main shift schedule. In fact, in Canada, companies experience a great mix of workforce. People from Alberta are able to work short shifts, others travel outside Alberta, and so their work period should be at least 14 to 17 days. This creates a very diverse shift of schedules. A typical IWP size is calculated as follows: for 10 days on and 4 days off site at the rate of 10 hours per day for a crew of 10 workers, an EWP is then about 1000 man hours. One IWP corresponds to one work shift. This can deviate for other reasons like weather and constructability issues. With the conditions of work in Canada depending on shift schedules, the work packaging process have to be flexible.

Content:

- Drawings

- Specifications
- Bills of materials
- Scope of work description
- Permit requirements

IWP content

Below is an extract of items included in an IWP developed by Company J:

- Scope of work + checklists
- Safety assessment documents
- Bills of material
- Shift work assignment
- Surveys related to time lost or workforce issues
- Drawings
- Inspection documents
- Vendor data

Tracking EWPs and IWPs

There two phases in the planning process as perceived by Company J: the **static planning phase** and the **dynamic planning phase**. The transition from static planning to dynamic planning happens as soon as IWPs are issued to field. The dynamic planning phase happens during the construction phase. Progress is measured by unit of measure and once a work package is completed, the package is closed. On the static side, the progress measurement is done according to the schedule. For each task, there is a start date and a deadline. For instance, a typical IWP takes 51 days to be prepared. This is a critical path (minimum). Every step during those 51 days is monitored. The content is monitored. Planners (called constructability coordinators) are designated to come up with the scope definition (materials, tools, documentation, etc...). They also communicate with other functions especially the estimating function and project controls to align cost codes, the supply chain etc.

For the majority of materials needed for the type of work Company J does, 51 days is enough to have the delivery order issued and delivery done. Company J does not order major material. This is done by the owner. Company J is involved with the civil work needed in the project.

Communication between the construction side and the engineering side

Expert 17 thinks that ideally, construction side gets involved early in the FEED phase with both the Engineering side and the owner side.

The basis for a good communication is not to have the engineering side develop alone the EWP release plan. An agreement on the EWP plan should be done before the starting of the IWP release plan development. Construction people should be heavily involved in defining the boundaries of the EWPs. EWP release plan is the core communication item between construction and engineering sides. IWPs are developed internally within Company J and do not involve engineering. Company J assigns a FEED planning team that works with the owner and engineering. It also have a construction planning lead and a construction manager involved whenever possible in the FEED phase. Construction people from company J get involved in FEED in an informal way and it is only when the owner encourages the process. In the majority of cases, company J representing the construction side gets involved during the detailed engineering phase.

Change management

This involves project controls and other functions. As soon as there is a change that affects cost, resources and schedule, it touches every other function and task. If a new revision is received containing additional material, if company J already completed the IWP and completed the definition of the estimate, this change is considered as an extra scope and is submitted to the client to get approval. Change after completion of IWPs and scope are tracked separately and have a different cost code.

Needed change initiated by company J is communicated through RFI. An RFI if done during FEED is incorporated in the scope, if not (during the dynamic planning phase) it is treated separately.

Cultural changes

During the first 4 years of WorkFace Planning implementation, the process had known a lot of development. Internally, field crews did not accept until foremen and superintendent started buying-in. Company J made a number of trainings and workshops.

Organizational perspective

There is a position of WFP implementation lead that is currently not filled in.

Areas of improvement

- There should be good coordination between engineering and general contractors especially in software usage. In fact, EPC contractors use software tools that company J as a civil contractor does not utilize. Requiring company J to provide documents in another format than the one used internally is additional non-adding value work.
- In matters of project controls, EPC contractor requires company J to report cost for each task while company J uses work packages to structure the cost breakdown structure. This is a challenge related to reporting between contractors and general contractors.
- For instance, when EPC contractor provides steel for structure work, our workers install that by erection drawings and follow tagged items. The tag lists given from the EPC contractor are very often incomplete which makes company J to use internally different tagging codes. This leads to risk of mixing pieces from the Project Controls side

Summary of Benefits and Challenges

TABLE 13 SUMMARY OF BENEFITS AND CHALLENGES

Benefits	
Better communication Schedule by IWP WBS lineated with WFP structure Easier control and adaptation to the workforce conditions of the Canadian market (shift schedules)	
Challenges	
Not all engineering companies follow the WFP process in the EWP release plan – Engineering companies don't always have the same way of doing the EWP release plan	Expert 17 stated that currently, they are working with an engineering company that previously (in a previous contract)had an EWP release plan, but now, does not that anymore in this project.
Owners and Engineering are still not familiar with the WFP system	They are uncomfortable seeing indirect cost of WFP without rapid tangible results
Tagging codes mixed	See areas of improvement
During the implementation, owners did not pay for the extra indirect cost	

EXPERT INTERVIEW 14

Company overview

Company K is an Engineering & Construction company (2 billion dollar).

Company K provides engineering, construction and maintenance services to global markets in the oil and gas industry as well as electric and natural gas utility transmission and distribution. From its century-long heritage of being principally a global engineering, procurement and construction (EPC) firm for pipeline systems and related facilities, with recent acquisitions Company K now provides its integrated services offering to multiple end markets including upstream, midstream, downstream and electric utility markets. Most of the company work is in Western Canada and in the U.S.

According to expert 14, the main contracting type is on lump sum basis. For upstream work, the typical driver is schedule. For downstream work, the main driver is cost.

Expert characteristics

Background and professional experience

Expert 14-a is the chief of operating office within the company. He has 40 years of experience. He spent 35 years in another global engineering, construction and services company before joining company K where he has been working for 5 years.

Expert 14-b is the vice president of the project management office of the company. The project management office works on project controls, estimate, scheduling, cost control and coordination of training related to project management skills. Expert 14-b has 30 years of experience and has been with company K for 6 months by the date of the interview.

Both experts were in the same company before joining company K.

Work Packaging Processes

Level of implementation:

Company level	**X**
Project level	

Overview of the work packaging process

Experts 14-a and 14-b agreed on the fact that there is no documented and formal procedures of work packaging existing within the company. However, work packaging terminology exists and some practices during FEED and DE are in place. In fact, in early stages, work is divided by area. Areas can be utilities, processes etc... those areas are then sub-divided. The time this work packaging breakdown is done depends on the contracting strategy (e.g. for an EPC design bid build project, the breakdown has to be done early enough before the proposal is out. Expert 14-b thinks that the general rule is to have it done early enough in the design so that you have time to align the schedule, the cost estimate and the engineering with the breakdown.

For company K, an Engineering Work Package (EWP) is basically the set of engineering drawings. A Construction Work Package (CWP) is composed of materials, crews and engineering deliverables or EWPs. EWPs are discipline based by sub area. For example, considering a process plant divided into subareas that are also subdivided into disciplines, for this case, a CWP is the subarea containing the set of EWPS that are the corresponding disciplines within that subarea.

The breakdown of the project incorporates the construction sequence/ execution sequencing and the work packaging structure is perfectly aligned with the WBS. **Experts have agreed on the fact that work packaging breakdown is a subset of the WBS.**

Experts emphasized on the importance of the early consideration of procurement issues. In fact, they think that procurement is an integral part of the work packaging process because the procurement schedule can heavily impact the execution sequencing. Within company K, **procurement schedule is incorporated in the work packaging schedule.**

The work packaging process is scheduled and coordinated by the project controls office within the company.

Communication between the construction side and the engineering side

During FEED, there are formal meetings with people from both engineering and construction side. The objective is to make the engineering side support construction from an

early stage. The construction people usually involved in this early communication process are the construction manager and the superintendent. Experts 14-a and 14-b thinks that ideally the people who are fully assigned to the project should get engaged in this early communication process.

Tracking engineering work packages

In the construction job site, company K has a visual space for CWPs and EWPs letting people on site track the availability of EWPs. The following figure shows the way this is organized on site. As soon as an EWP is complete, it is sent on site to feed the correspondent CWP. A CWP contains EWPs, material list, craft planning and construction equipment.

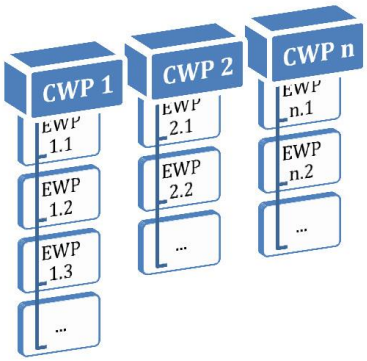


FIGURE 18 WORK PACKAGES ON SITE

Cultural changes

The introduction of the work packaging language and structure was informal and no training was engaged.

Organizational perspective

The project manager and the project management office is responsible for coordinating the FEED phase and providing the level 2 schedule as a draft for discussion of the execution plan. Adjustments are done with consideration of the alignment of interests and considerations of every stakeholder. No formal tools are used to help conduct FEED meetings.

Contracts

Experts 14-a and 14-b emphasized on the importance of the contracting strategy to foster work packaging systems. In fact, they gave the following scenario:

A: Engineering B: Construction and the owner aligning all together. If A and B are lump sum contracts and the project is fast track, experts think that this can be a "disaster" for work packaging. However, if the project is reimbursable, the contracting strategy supports the idea of engineering early collaboration with construction. Experts 14-a and 14-b agree on the importance of the owner (or who ever does the coordination between EP and C) to be driving the work packaging process.

Summary of Benefits and Challenges

TABLE 14SUMMARY OF BENEFITS AND CHALLENGES

Benefits	
Logical way and easy to understand	
Facilitates for project manager to situate their work status in a big and complex project	Helps is defining a big picture with a sufficient level of detail
Challenges	
Incorporation of the execution sequencing	
Dynamic of change	Late delivery drawings, weather impact, delayed material delivery etc…is a challenge for the consistency of work packaging
Feasibility of the original plan	Making sure that the original plan is achievable and feasible can only be ensured by the use of experienced people in early stages of work packaging. Experts 14-a and 14-b think that work packaging is usually done by newly graduated people or people with limited experience in the construction industry, which leads, in their opinion, to exaggerated schedules and non-achievable plans. Experts 14-a and 14-b think that experience of those who start the work packaging process is a key to its success.
Neglected enough procurement consideration	Procurement is a key piece for realistic schedule and then consistent work packaging structure. In a

	lot of cases, this piece is missing.
Change management	When there is a deviation from the original baseline, how this deviation is measured and monitored and how change is incorporated remains, in Experts 14-a and 14-b opinions, a bug challenge in the work packaging process. Experts 14-a and 14-b think that change should be tracked separately from the initial baseline plan.
The level of engineering work in FEED is usually very high level and depends a lot on the contracting strategy (DB, DBB)	The breakdown in FEED can be very inaccurate and incorporates between 10 to 20% of design which leads to a lot of variability affecting the work packaging effectiveness.
Conflicting work cultures	Expert 14-a pointed the fact that the way engineering work is executed is opposite to the way construction people execute work. In fact, the classical engineering sequence is executed from up to down (civil work is one of the last designed parts). However, construction starts with civil work. Experts 14-a and 14-b agree on the conflicting nature of this way of executing work.
Engineering efficiency is very important to engineering economics.	Delta engineering and delta construction from a cost perspective are, as considered today, not in favor of the work packaging philosophy of early integration of the construction sequence as the primary driver of planning. Experts 14-a and 14-b recommends early negotiation of the allocation of resources depending on the project strategy too.

EXPERT INTERVIEW 15

Company overview

Company L is a global gas producer with heavy activity in North America. Most of the contracts and E&P but the company does also E and EPC less importantly. The company (Alberta office) has recently assigned one person to work full time as a WorkFace Planning manager. He has been working for 6 months now. Company L uses WorkFace planning per COAA definition.

Expert characteristics

Background and professional experience

Expert 15 has worked for company L for more than 20 years and have held different positions in different locations between the U.S. and Canada. He is currently occupying simultaneously two positions: manager for construction in Alberta Canada and manager for construction engineering in all Canada. He had a master in civil engineering from an American university.

Work Packaging Processes

Level of implementation:

Company level	**X**
Project level	

Overview of the work packaging process

Expert 15 thinks that the first condition to a successful work packaging system is the early consideration of construction in the project scope and engineering work. The way company L conducts engineering work is defined through two main scenarios:

1) The engineering firm is part of company L and in this case, company L determines then the breakdown of work (by system, by size, by area etc...)
2) The engineering firm is not part of company L and not familiar with WorkFace planning and in this case, company L takes the responsibility of

providing the needed training. The criterion for job breakdown is the result of a joint discussion in this case.

Typically, expert 15 said that company L does not have construction people on board in the FEED. The construction side eventually being involved is represented by the construction manager or the superintendent. This early collaboration process is a new concept. Construction people are not systematically involved early in the project. The construction review process is always done by the engineering side.

Expert 15 mentioned that company L decides about using WFP based on the size of the project. Typically for projects between 25 and 50 M$, WFP is not implemented. For more complex and bigger projects (up to 400 M$), WFP is considered to add value to the project execution productivity and predictability.

A Construction Work Package (CWP) should contain drawings (or EWP) and specifications, material lists and equipment info. Within company L, CWP per COAA definition was skipped and there was only directly development of IWPs for smaller projects.

During Detailed Engineering, expert 15 explained a theoretical vision based on which the construction engineer should have a seat in the project table during this engineering phase with the project manager, the project engineer, the discipline engineers, project controls people and quality control people. In this team, the construction engineer should be seen as a member that is adding value and not as a constraint. The discipline construction engineer is ideally a person with experience in the construction field, who has worked for the company for 15-20 years and who realizes perfectly the issues that the company faces during construction with an insightful vision of constructability

In reality, this team is not always as complete and the construction engineers are usually hired right after graduate school or with less than 5 years of experience. A more mature staff is needed for the success of the work packaging system.

The content of an IWP is as follows:

- Scope of work
- Quality plan
- Risk/safety
- Schedule

- Equipment/tools
- Special tools (crane plan etc...)
- Drawings

The size of an IWP depends on the contractor, the type of work, the craft schedule and the area itself.

Company L uses IWPs completion for payment. IWPs are the metric for work progress measurement and for payment. Expert 15 mentioned the importance of flexibility in payment per IWP because this metric is still not very accurate and the work will be often decided by the construction superintendent for the benefit of the project.

Communication between the construction side and the engineering side

Construction people are on board during FEED and DE phases to be able to generate with other team members the work packaging sequence. Expert 15 mentions the resistance of engineering in working collaboratively with construction people as WorkFace planning is not pushed enough to a fluent implementation level between engineering and construction.

Cultural changes

Expert 15 thinks that the owner should be the one to drive the work packaging system implementation because it is the party that defines and proves the scope of work.

Expert 15 thinks that change is always difficult and he suggests the importance of education. He also suggested that trainer and external consultants, when coaching owner and construction people, they should bring people from the engineering side too. He thinks that a training for a week can be helpful to know basics but will not benefit the dynamic of the project unless people from engineering are present.

Organizational perspective

No Use of external consultants to guide teams. No significant organizational change.

Contracts

Expert 15 thinks that construction contracting strategy and planning should come from the construction people who are knowledgeable of the nature of work and its challenges. He

also thinks that the contact should include clear mention of the fact that the use of WFP is mandatory. He also mentioned pre-qualification requirements that might include this condition.

Summary of Benefits and Challenges

TABLE 15 SUMMARY OF BENEFITS AND CHALLENGES

Benefits	
Value of WFP depends on the project size	For relatively small projects, expert 15 thinks that WFP from his company perspective
Opportunities for improvement as suggested by expert 15:	
Owners efforts to drive the process	Expert 15 thinks that initiation is a difficult process that has to be understood by all contracted parties. There is a need to articulate and identify the value of work packaging when you require and train other people to use it. Expert 15 gave the example of a project he worked on few years ago, a large complex project E P C: the engineering company and the owner started together, the engineering firm had experience with WFP and had one assigned person to WFP implementation. However, this project was an exception, since company L usually assigns one of the construction engineers to take care of WFP implementation on a part time basis.
Need for a WorkFace planning champion	Expert 15 thinks this should be limited to the first stages of implementation.
Challenges	
When engineering firms are not familiar with WFP and work packaging, they need education provided by an external stakeholder (more likely owner)	For small engineering firms, the work is planned by hours to deliver and WorkFace planning is not part of this plan. Expert 15 thinks that WorkFace planning still requires a considerable amount of work especially in early implementation
Experience of discipline construction engineers	

EXPERT INTERVIEW 16

Company overview

See below company E

Experts characteristics

Background and professional experience

Expert 16 is a construction manager with 35 years of experience. He has been using work packaging for the last 3 years with Company E. Expert 16 testimonial focused on perceived benefit of using a combination of lean construction practices and a customized WorkFace planning.

Work Packaging Processes

Level of implementation:

Company level	
Project level	**X**

Project's characteristics:

Despite the fact that the company is a big owner with global large projects; this specific project is considered as unique from the company's standards perspective. In fact, the team was built under the Operations Office umbrella and adopted a combination of lean practices and WorkFace planning.

Processes:

- Use of lean visualization tools combined with Work Packaging. Those tools were used to visualize the progression of work packages.

- Safety meetings: the team, including workers, were all being involved with the safety process. They were all asked to identify risk items. 131 identified items by the team were discovered on field and removed.

- The WorkFace planning process was inspired from the COAA model. However, there were modifications: the COAA process was partially used. The driver to the change was not to make people overwhelmed with paper work and detail. It was combined with Lean technique: Last Planner System (LPS).

Requirements for success:

- As a requirement for success, the manager mentioned that all team members were required to be lean facilitators. Expert thinks that qualified people are the key to any process implementation success.

- Work packaging requires the engineering construction team to come up with previous improvements learning and share them with one another. E.g. in 2011, the company needed to proceed civil work in one of its plants. Work has been estimated to take about 80 days. The company teams had sent 22 subjects to local contractors and have provided to them trainings regarding lean and work packaging. Two teams were selected and then asked to re-think the work and come up with the most optimized schedule for the same work. The result was a schedule of 23 days. The actual project after executed took 26 days, which is about 67% time reduction. This team included the vendor as a partner. The fact that there was an existing established relationship with the vendor helped reduce the time and is the basis for a long term relationship.

- Expert believes that leadership is important to the success to any process implementation. He said that when the manager and supervisors believe in the importance of the project, they convince other workers and members of the project and influence their efforts to get things done properly.

- Progressive implementation is important. Keeping track of previous experiences and preserving the knowledge experience within people and relationships is important.

Perceived benefits:

- Productivity improvements: 15% to 20% productivity improvement
- In 2011: 3500 hour work with zero accidents
- In 2012: 3800 HW with same safety performance; equivalent to 30% improvement in productivity
- Productivity is analyzed with safety performance.

EXPERT INTERVIEW 17

Company overview

See below company E

Experts characteristics

Background and professional experience

Expert 17 is a project manager. He has been with company E for one year and a half. He has 7.5 years of experience after graduation. He started in the manufacturing industry and has joined the oil and gas industry for the last 5 years.

As far his construction experience is concerned, he has always been from the owner side. Expert has been working with WorkFace planning for 5 years. He was in the first set of implemented procedures of WFP in Alberta.

Work Packaging Processes

Level of implementation:

Company level	
Project level	**X**

Project's specificities:

- Does not follow the company general procedures and guided process.
- The team is not under the projects group of the company (which is typically the case within this company).
- the project environment is determined and designed by the team
- The team is given the freedom to come up with their own processes and procedures
- The type of projects are typically large and the team focuses of the portion of expansion of existing plants.

Context of work:

- To address the tailing challenge associated with the development of oil sands mines, company E developed a new tailings management approach that is expected to significantly improve the speed of tailings reclamation.
- The objective is to reduce the containment of water that is used in the mining process.
- The company cancelled the construction of the programmed traditional tailing ponds. The total land area covered by the ponds is expected to shrink to 80%.
- The new technology developed to enhance and better the tailing management process introduced changes to those plants. Expert 16 are taking part in the expansion of the plants to implement the new system.
- Expert 17 mentions that work packaging helps manage the work in this context.

Work Packaging Process description

In the early scope development, the contractor(s) is not involved. Company E has a team that works on ensuring the readiness of the scope of work, drawings and materials in advance. The front end planning in company E within the scope of this office is done entirely by the company people. Many groups are involved during this phase; e.g. engineering group (geotechnical, mining etc.) procurement group etc...

After the scope is developed from a constructability perspective, the bid is prepared with respect to the time and materials.

After the contractor is selected, company E works very closely and collaboratively to ensure the success of the project. Regarding the payment method, expert 17 mentions that they pay contractors on an hourly basis. Expert 17 thinks that this payment method increases control of the contractor's work and execution of work packages. Expert 17 thinks that work packaging combined with a short term payment schedule help the owner drive the work and be in control.

Regarding the selection of contractors, expert 17 mentioned that since contracts are usually short term contracts, company E takes into consideration the quality and the level of detail provided by the contractors in their proposals. Expert 17 gave the example of a selected contractor with the highest price which provided the highest level of detail regarding project execution plan and work packaging system. With this selected contractor, the company finished the project with 15% under budget.

Company E believes in managing the contractor's work on a daily basis.

Work packaging structure:

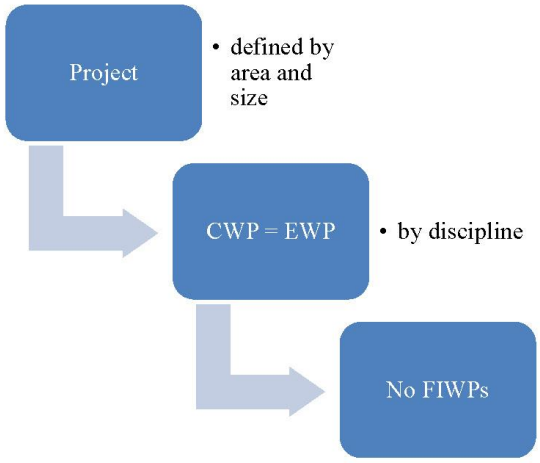


FIGURE 19 WORK PACKAGING PROCESS

Construction Work Package (CWP): CWPs are discipline based. Expert 17 mentions that EWP and CWPs are the same. The breaking down process of projects into CWPs is based on two criteria: the **size** that should be manageable and most importantly the **logic of work execution**.

Organizational perspective

For each project, there is a WorkFace planner and a scheduler. Those two positions are distinct. Expert 17 mentions that company E expects each contractor to be familiar with WorkFace planning and learn the company way of using the work packaging process.

The difference of understanding creates inconsistencies. Company E prefers to have a full time WorkFace planner and a scheduler rather than training and forming contractors' schedulers in WorkFace planning. This is perceived to be cheaper and more consistent.

Contracts

Expert 17 mentioned that the lump sum contracting strategy can work with work face planning only if: - the owner trusts the efficiency of the WorkFace planning system by the

contractor and – the owner gets the benefits and budget savings from implementing WorkFace planning.

EXPERT INTERVIEW 18

Company overview

Company M is an American Engineering, Procurement, Construction and Private military contracting company. Company M employs more than 27000 employees in over 70 countries. Services offered include: Downstream; Gas Monetization; Infrastructure & Minerals; International Government, Defense and Support Services; North American Government and Logistics; Oil & Gas; Power & Industrial; Services; Technology; and Ventures. Company M is the contractor for the largest Australian natural gas project that is a joint venture between two large American Owners. The procurement side is characterized by the use of an Integrated Project Management System (IPMS) that has been shaped and developed to fit company M's work and need. The system has been in place since 1993 and is currently used for this large natural gas project.

Expert characteristics

Background and professional experience

Expert 18 is **System and Integration Manager** within Company M. Expert 17 is based in Australia. She has joined company M since 1993 and has in total 23 years of experience in the construction industry. Expert 18 has been working with an Integrated Project Management System since 1995. The system was introduced in company M in 1993. Expert M is currently working on a joint ventured natural gas project.

Work Packaging Processes

Level of implementation:

Company level	**X**
Project level	**X**

Expert 18 explains that the Integrated Project Management System (IPMS) is an Oracle data base that aims to reduce redundant data entry regarding procurement. The system that was in place before the introduction of IPMS was not integrated. In fact, data regarding

engineering requirements (e.g. pieces of equipment, design, procurement, delivery and installment) were added manually, which increased the risk of error and redundancy.

The project that expert 18 is working on is not only a joint venture from an owner's perspective but also in engineering too. The joint venture is between company M and another engineering company.

Overview of the procurement perspective of work packaging

What drives procurement?

"For procurement, nothing starts without the engineering deliverables (specifications and drawings).

We are under the supplier mercy when it comes to deliverables based on which we make our schedule".

A Procurement Work Package: PWP

1) Engineering requisition

2) Procurement milestone

3) Pre-quotes

4) Purchase Order issues

5) Shipment to site details

PWP development process:

- Engineering side identifies all EWPs of the project.
- Key procurement milestones are developed in collaboration with engineering
- PWP release plan developed by the procurement team in collaboration with the engineering team

-> A list of PWP is almost complete. Each PWP completed is tracked regarding three main info: 1-the baseline date 2-the expected date 3- the actual date

This process is a collective effort between procurement team, engineering team and materials management team. Expert 18 said that with few exceptions, the current PWP release plan is consistent with the actual plan.

Organizational perspective:

- There has been a dedicated resource for the development and maintenance of PWPs.
- The materials management team is the one who is responsible for the maintenance of PWP.
- The materials management team applies a "quality control" regarding PWPs.
- The content is part of the engineering responsibility.

Procurement Challenges

Challenge 1:

IPMS bills of material have not been created to accommodate with existing packaging system

For example let's consider a package of isometrics

In IPMS items are identified by two locations: shops and field

The project is located in an island where there is limited space for storage. In fact materials and equipment should be sent just in time.

This is why in this project we pre-assemble equipment on the main land before sending them to the island.

We have then a new step in the procurement cycle that is pre-assembly in a different location that the existing IPMS does not take into consideration.

For instance, let consider item A which is composed of sub-items A1, A2 and A3.

Within IPMS, those sub-items are tracked separately in the shop and in field. The field work package contains items in their original take-off and not in the assembled status.

A field work package would contain A1, A2, A3 and not A because it is based on the IPMS system that tracks sub-items.

This process implies the loss of visibility regarding the step of assembly in the procurement cycle.

Recommendation 1:

The only solution at this stage is to track one package at the time.

The loss of visibility has an impact on the planning quality because in order to have an effective planning, we need to make the right choices regarding procurement decisions.

Loosing track of the intermediate step of pre-assembly on mainland has been affecting the accuracy of the developed plan.

Challenge 2:

The purpose of work packaging is to be used as a planning tool. It is meant to be a reliable information tool ahead of time.

However, work packaging, as implemented in this project, is almost done on just-in-time basis. It does not allow early preventive action.

Expert 18 said that early planning takes into consideration procurement. However, the main issue remains that it assumes that pre-dressed materials will be delivered on time. The needed adjustments that comes along the project lifecycle cannot be done easily with the existing work packaging system that we use.

Recommendation 2:

There should be a better consideration of change management regarding procurement. Expert 18 mentioned that "we are under the supplier mercy when it comes to deliverables that are determinant of the schedule"

Challenge 3:

An engineering joint venture is a challenging situation for the procurement side of the project. In fact, issues can arise from the fact that one of the engineering sides is not familiar with the work packaging process or have different incompatible systems in place.

Recommendation 3:

Training and education; more meetings and communication

Challenge 4:

Resistance to change

Expert 18 said "a typical person in our industry is more comfortable with his pre-existing working tools and methods"

Recommendation 4:

Expert 18 thinks that education is needed. He thinks that the most important point is to ensure that every stakeholder understands his own role and its importance to others.

Even for stakeholders that are not directly interfering with IPMS need to understand the concept behind this system and its importance.

Benefit:

The IPMS implied more collaborative work environment.

Contract:

Expert 18 has no experience regarding contracts.

EXPERT INTERVIEW 19

This interview played the role of a concluding interview as the interviewee was chosen to be a researcher and consultant in work packaging and technology. This provided insight about general themes in the industry rather than specific company practices.

Expert Characteristics

Background and professional experience

Expert 19 was the founder and president of a company that developed tools for WorkFace packaging and planning and helped create standard for WorkFace packaging.

Experience with work packaging

Expert 19 worked at national research laboratory to build work packages for robots. He worked on a contract with a construction company to control equipment. He then used these techniques for work packaging on telerobotics. From 2000 to 2008, he worked on Advanced Work Packaging for industrial and construction.

Work Packaging Processes

Expert 19 has worked on automatizing the process of work packaging projects applied to different fields. He mentions that the majority of companies now would package their work on paper. Expert 19 looked at 4D and evolved how you could build a plant down to components in virtual model.

Significant challenges

1. Preliminary challenges

- Engineers lack of buy-in because of the culture of packaging work. Expert 19 mentions that CAS packaging boundaries are defined about 10 years ago and can be aligned with CWPs.
- "Who is going to maintain the definitions as project evolves?" a question that usually is not well answered and causes problems.
- Construction responsibility: expert 19 thinks that responsibilities toward the success of construction is not shared by every stakeholder.
- Paper or excel spreadsheet become nightmare – too many, not easy to update

- The Engineering side is not responsible for maintaining package
- There are some companies that put planners into their companies but couldn't keep up with changes that would affect flow and flow of CWPS and IWPS
- Cannot track on paper – paper based elements/ packages are
- Engineers were coding work packaging definitions into 3D models but were how to facilitate engineering processes but not necessarily construction process
- Engineering model-doesn't have granularity for how things are constructed, it is not designed based on constructability
- Discipline to discipline - tools facilitate drawing of layout but doesn't break up into constructible elements
- Amplified when go into civil and architectural
- Downstream break down into parts
- work packaging and engineering miscommunication
- Can't determine best way to build until is finalized the design process
- CAD models have evolving levels of details
- Early CAD models are not advanced enough to do packaging
- CWP boundaries are not fixed, change management in validity as construction companies
- Engineers are not involved enough in early construction management
- Early packages v later refined packages

2. Process related challenges

- Rarely are plans correlated to real schedule
- Reporting problems after they are already delayed
- Still becomes disconnected to original CWPs and gets off schedule that they are building
- Doesn't want to be told they are doing their best job
- No one wants to be told they can't do it
- So much as changed and plans aren't updated
- No way engineer can be responsible to make all the changes
- When const. manager has tools to follow changes it all falls apart
- Way to maintain revision updates, agility and planning
- Industry to does not have technology

- Last of visibility

3. Management related challenges

- Different software languages (software)
- levels of details different than
- Work flow depends on the constructor not the engineering management
- The owner pays the price financially – this cost should be carefully shared
- Lack of visibility
- Low productivity rates have a compound effect on work packaging execution line
- How work is planed doesn't match how it was being built
- Expert 19 thinks that things won't improve dramatically in the construction industry comparing to other industries unless there is heavier automation
- Company that is building it is not the company that making the input into how CWPs are organized
- the fact that companies tend to have up to 3rd issue and even more for one package shows how change is constant from a management perspective and the revision of CWP definition
- No automated way to adjust changes
- Need to develop automation tools
- Construction need to see the changes that are happening in the packaging process – this requires visibility reached by automation
- Don't have visibility and automation where changes in other parts how they affect package definition
- Expert 19 mentions that because of the burden of the process being not automatized, a lot of companies stopped believing in packaging process
- Cultural issues with management styles
- Major construction companies say they have all the technologies and don't perceive or recognize that they need to adopt and invest more and more into improving their processes
- The way the construction industry is set is to push contractors to say they are doing better than their competitors even though this is not the truth
- For the same reason companies are still struggling but saying they have it solved
- Doesn't take into account that engineering and construction are driven by different principles

- Dangerous to overly simplify
- Without automation tools, the work packaging cannot be done efficiently or practically
- When IWPs and CWPs are defined and they change, they can't keep enough staff to maintain the changes
- the process as currently set up requires an "army of people" – heavy investment from an HR perspective too
- How to adjust revision management without automation tools is a question that has not been addressed yet
- Industry doesn't want to dictate construction

4. Recommendations

- Define CWP boundaries as early as possible – they have to be fixed and then eventually add layer
- As engineering evolves, design of plant determines how plan is going to be built.
- Visibility of planning of project
- Define output of individual production
- Packages definition of the entire supply chain so you can relate packages across subdivisions elements
- Go beyond, have relationship between companies and subdivisions between companies
- Work package blocks that are dependent needs better definition
- All stakeholders should have inputs and outputs of work packaging
- Developing pre-selection development tool
- Include in questions about whether contractors have automated tools for work packaging or not
- Work with another operator – can be external
- Dictate deliverables format and expected result
- RECOGNISE-CWPs are not a onetime event but must be continuous and redefined at multiple stages
- Solution to track change separately and leave responsibility to project manager
- Recognize intermediate layer that exists
- Make sure the refinement of schedule is based on how they are going to be build
- Constructor needs to have influence and make the estimate based on how it is going to be built

- Need automation systems to keep track of changes
- Engineering-organized to produce output (drawings) best organized by system breakdowns and stability to break down own team
- Fabricators teaming up to minimize cost of producing pipes optimization principles

5. Gains

- Advantage to having boundaries fixed so you can have tracking during the project
- Economic incentive to keep plans up to date in what you are doing
- EAC company can keep plans up to date and publish them
- Get huge gains by staying with plans.
- Plans can be correlated across divisions across company
- Automation increases productivity

Summary

Work packaging has the potential to maximize the construction industry tremendously. It could

- Decrease costs to owners
- Save time during construction
- Prevent issues/delays/miscommunications/inefficiency
- Increase productivity and somewhat reputation of construction industry

Appendix D. Validation interviews questionnaire

The following questionnaire is designed to help you collect your thoughts regarding the RT 272 Implementation Resource volume 3. These questions will guide the phone interview and do not need to be formally written out prior to the interview. Please review these questions prior to and following your reading of the RT 272 Implementation Resource volume 3 as they will help you to understand the kind of feedback we would like to receive. Thank you for your time.

1. Understanding of proposed model and recommendations

- Is the report well organized and easy to read?
- Is the level of detail within the report appropriate?
- Did any specific information seem lacking or extraneous?

In Section 1

- How does the proposed Advanced Work Packaging process differ from WorkFace Planning? From traditional/current work packaging practices?
- Do you think that the maturity model is well designed to assess a company's ability to implement Advanced Work Packaging?

In Section 2

- Were the contractual recommendations clear? Was the level of detail of the discussed strategies appropriate?

In Section 3

- What aspects of the proposed Advanced Work Packaging process were most clear? What aspects need further clarification?
- Were the functional capabilities well described? Was the distinction between the new AWP related positions and the modified existing positions clear?
- What do you think are the strengths and weaknesses of the suggested process?
- Did you find the "Owner experience AWP implementation" section useful?

In Section 4

- Did the tools seem like useful aides for implementing the suggested Advanced Work Packaging?

- Did they lack detail or contain too much information? Were any implementation tools missing?

In Section 5

- Was the example proposed in the document helpful in understanding how AWP can be implemented?

2. Implementation/Practicality

- How is the proposed Advanced Work Packaging model different or similar to your company's Work Packaging methods?

- What aspects of the proposed model for Advanced Work Packaging would fit well within your organization? What aspects would not?

- What would implementation of the proposed Advanced Work Packaging model require of your company? (For example, organizational change, technology upgrades, procedural changes)

    - What are some "selling points" of implementation?

    - What are some barriers for implementation?

- Would you recommend the Advanced Work Packaging model to your company/organization?

Appendix E. Validation interviews write-ups

Interview V1

Understanding of proposed model and recommendations

Experts said he liked:

- The layout
- The graphics
- The level of details that helped the understanding
- The examples provided
- The illustrations

He noticed that he found extraneous the contract part about E,P,C, and all the graphics are too separate

The constraints are not discussed anymore in the volume

Section 1

1. The difference between WorkFace planning and AWP is quite clear
   figure 1 shows the flow➔ what deliverable?
   Figure 6 is quite hard to understand, maybe the figure should be divided in three graphics instead of only one
2. AWP/WP: more focused on the main product, it is more focused more detailed, it adds more value
   to implement WP, the volume is a good model

Section 2

1. Contractual recommendations are clear
   Level of details should be condense to keep what is fundamental
2. Recommendations: In the expert's opinion, the biggest challenge will be e engagement of construction component.
   He wants to see another information on how concretely, we do the EP contract.

Section 3

1. Process integration flowchart is very good
2. Functional roles are well explained as the lector may be confusing between the new roles and the positions that have changed. The distinction between the two categories is not very clear

   He found very helpful the details about the roles and the responsibilities of each ones.
3. Owner experience part is useful because this part includes all the findings, the contracts.

Section 4

Templates are well organized, good and helpful to understand the context, they illustrate well the contents

expert found they had an appropriate level of details.

Section 5

Example: is very useful and excellent. The level of details is definitively appropriate.

It does help to implement AWP

Implementation/Practicality

- AWP ➔is different from WP: it relies on the engineering contrarily to work packaging
- Expert found the check list were useful for the package to be sure that they have not forgotten anything
- Selling points: Key is that it can help to predict the performance, improve the reliance on the schedule and the predictability
- Cultural barriers: it is a new method and industrial people will not understand how it works. Furthermore owner can show resistant to adopt this new model
- Experts will recommend AWP for this own company, he sees this process as a great gain of time and performance.

Interview V2

Understanding of proposed model and recommendations

Easy to read and well organized

Detail: in general satisfying level of details but expert finds that the audience will have a certain experience, at least 10 years and will have worked on many large projects, so they would be like him, familiar with contracts. So He does not feel that the contract part was really appropriate in the whole volume. According to his opinion the contract part should be condensed a lot with all the sections dealing about strategy
As CII study goes through all the details including the contract part it should be enough.

He feels like nothing is missing, yet he finds the contract part extraneous.

Section1

Section 1 is enough clear to help a team who wants to implement AWP
The difference between WFP and WP: AWP is more a process than WFP. WFP is more present on the construction part whereas WP is a whole process. Expert highlights the fact that you can do WFP without WP and still have some benefits.
AWP is an advanced process of work packaging however sometimes owners are using their own technics instead of the process.

Well designed? Some companies already use WP, they do not know their ability to implement AWP, because the question is more about do they believe they have the abilities to implement AWP?

Section 2

The contract part seems extraneous for this expert. He does not understand why such a developed part is here in the document: he thinks this part should really be condensed at the fundamental points.

There is a risk for the contractor regarding the productivity, and this point is not acknowledged in this document, this point deserves to be developed.

Section 3

Functional roles: the distinction between the new roles and the changed ones is clear according to this Expert.
He would like to focus more about the material manager who has an important role in the AWP process. The supply chain is also a key point: the document needs for emphasis on this particular position because you have to give to the right person this particular position so you will be able to have a great supply chain work.

Section 4

The templates are really useful
In one flowchart: “productivity” benefits, he thinks the team wants to refer to the installation.
To calculate the productivity from WP, there is a discussion that is needed before proceeding.

WP checklist does help however the checklist is not complete for this expert. But the checklist is not organized in a logical order (for the contractor)

Section 5

The example is excellent, very useful, it provides an excellent illustration because it goes all through the way of the process, the CWP, EWP and the IWP.
It will help to clarify the process for many people

Implementation/Practicality

For large project, the whole process can be applicable; the main point according to this expert is how you go about it?

AWP have to join both the work of owners and the work of contractors. Because the contractors have their customized vision, they do not want to follow the industry guideline, they want to make the difference, one will probably be looking at others items or ideas to bring value to the process.

Selling points:

- The standard
- Section 5: deals with how someone can implement and follow one item

Contractors will get some benefits (very large complex project)

Interview V3

Understanding of proposed model and recommendations

- Volume is well organized but needs more introduction
- Page 6: speak about volume 1➔ needs some overviews
- Level of details is good: very detailed, lot of details in the contract section maybe too much details

Section 1

- The difference between WP and AWP is well detailed in volume 1 so this is what helps the understanding
- Maturity model: useful but it is more about program management than about project management, every project has different characteristics

Section 2

- Clear contractual recommendations : good section about the different contracts, strategies but with too much details
- The recommendations do help in a contracting strategy
  Have to think differently because of the different implementations

Section 3

- Flowcharts are good but heavy to read
  It is important to have this ➔ not a working document
  helps to develop tools..
- Everybody is looking at the easy solution:
  maybe the idea is to have a quick story with some graphics➔ quick start job with first level of detail then another level of details
  The document is good, an industrial can easily use it
- Functional roles: good job description but people want to do a kind of copy which is not possible

to be useful it has to become something else than job description (having expectations of positions: experience.. in addition to job description with IWP

- Owner experience: good idea

Section 4

- Templates : good as the checklists but no one will really use it, or will use it to help developing a package (helps to understand what goes in the package)

Section 5

- Section 5 not read but thinks that the idea of having this example going through all the process is good

Implementation/Practicality

- Selling points: detailed description system to support AWP with enough details
- Education about barriers: too much details, need to know what to do and when?
- Helps people in the company think about the implementation
- Recommendations are not obvious in the document with a lot of details at some locations

Interview V4

Understanding of proposed model and recommendations

The Implementation Resource looks pretty good – but not easy to read for an engineer looking for stand points directly (lots of paragraphs)

Too much Level of Detail in some places – contracting strategies is too much detail for the people reading this document who are supposed to have a considerable experience

1) Information and material translated by the word "flow"
2) Constructability is not very clear as well as supply chain management

Section 1

The difference between Advanced Work Packaging and WorkFace Planning is not clear – this is difficult for "pure" engineering to understand and capture – the world today is construction driven, "we are not there yet"

WBS, CWP & EWP should precede Interactive Planning. It is too late and too time consuming to defined these AFTER the interactive planning.

Section 2

Maturity model seems to be helpful…needs to be tried

Section 3

Designing the AWP, is in effect, establishing a process that will ensure information, equipment, and materials will FLOW to the jobsite in a timely manner to provide the craft person everything they need to do the work.

Expert thinks the FLOW concept from LEAN is extremely important. A construction project is in some ways very similar to a limited manufacturing process. Project Management is tasked with designing a process that will deliver everything required to the stakeholders along the production line:

- Scope of work requirements
- Process information
- Plot/space requirements
- Equipment related information
- Specifications
- All the way down the line to the craft person and on to turn over, commissioning and start-up

Section 4

Very useful templates

Section 5

Yes.

Implementation/Practicality

“As your team stated, this must be TOP DOWN DRIVEN

This can be in two scenarios:

1. The OWNER SHOULD DRIVE if they want to realize the benefits

2. A LUMP SUM EPC Contractor will drive if they understand the benefits.

Virtually impossible to sell this to most engineering companies.

There is very little in it for them, unless it is a CLIENT REQUIREMENT.

A GENERIC CONSTRUCTION COMPANY is using a slightly less structured version of this concept. They sort of "backed into the process" starting with a Construction Friendly Model and a field planner. Then they worked back into materials management, procurement, and engineering. It is working fairly well in that segment of the engineering part that works with construction. It is virtually unknown, and what's more, resented by the portion of the company that provides engineering services. They strongly resent being CONSTRUCTION DRIVEN. It has been quoted, "Construction does NOT tell us what they want. We tell construction what we are going to give them!" This company is not alone. This is the attitude of many engineering companies. Construction driven results in engineering doing "out of sequence work" (OOSW). OOSW leads to inefficiencies, rework, and confusion on the engineering side.

The GENERIC COMPANY has demonstrated that AWP to IWP works. However, it is NOT easy and requires a lot of front end planning, setup, and teamwork. In fact, we have only focused on Piping and Structural Steel. Yet to chase the other disciplines.

At my company, we are struggling to get engineering to establish a WBS in Front End Planning. It is like pulling teeth. If I am not there pushing, it probably will not happen. No one is pushing WBS and they have not even thought of AWP. The owners are non-players at this time. We need to emphasize the importance of preparing the ESTIMATE BY EWP that aligns with the CWP.

Another reason to promote AWP early in FEP is to ensure that the model is structured and designed is such a way to support getting materials to the job site and to support the extraction of IWPs. Very difficult sale to get engineering to do this UNLESS the OWNER uses a metric or reward/penalty on the value of the model to support construction execution. In fact, few if any of the available 3D Modeling software systems being used today, could be considered as CONSTRUCTION FREINDLY. Most were designed for engineering, with very little, if any thought for field planner and craft person. Simple things like field welds, piece marks, and spool numbers are non-existent in the models. Construct-Sim is an effort to shore up this problem, but that is another expensive program that is usually adopted by the construction contractor because they engineering contractor did not build the model with construction in mind."

Interview V5

Understanding of proposed model and recommendations

Study comprehensive: oriented to large companies and big projects

Cover what requires in AWP, familiar with AWP

Companies that have troubles with front-end planning should definitely move to AWP.

Level of details is very good, it is strength. If some companies want to implement Work Packaging, they do not have to find documentation or do some research, they will have to look at the implementation guideline.

Expert is an expert in construction and not in front-end planning , so he found the implementation process very good but does not feel able to find if there is anything lacking.

Section 1

The difference between WP and AWP is very detailed in volume 1

Maturity model: useful but it is more difficult to understand for construction people as they are not skilled to do the front-end phase

Section 2

Clear contractual recommendations: good section about the different contracts, strategies

The recommendations help in a contracting strategy decisions.

Section 3

Expert found that the chart p29 is very good and is very helpful, easy to understand. This chart helps to understand every deliverable and who is in charge of each.

Functional role is not easy to understand particularly for people from the construction side, but the chart p29 is a good illustration

Section 4

As a construction expert, he found that the checklist is a really good idea however is not exhaustive and some items can be lacking to really ensure that everything is ready. Moreover some items are not in a logical order.

Section 5

The example is excellent: every step is well described and easy to understand. One of the key point of the implementation guidance. AS this example goes through all the process , it provides a good illustration of the model developed by the CII and how it must be implemented.

Implementation/Practicality

As a construction expert, he found that some information are lacking, he will not felt enough skilled to implement AWP by himself. The model and the volume had enough details to be understood.

As it is a good project management program but expert found that he would be able to do it:
If the process is not described it does not tell how to proceed
how to start on day one? What should people do the first day and the others?
For this expert some information are lacking as he does not know what to do or how to start.

Interview V6

General Comments

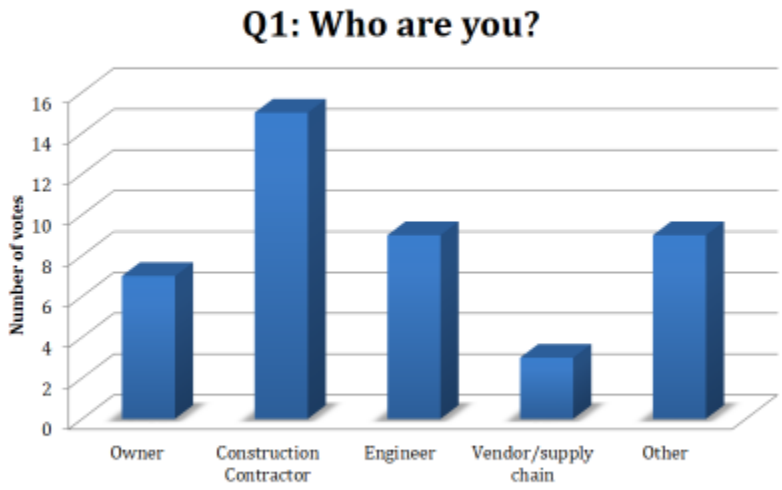
NB: THIS INTREVIEW DID NOT FOLLOW THE ORDER OF THE QUESTIONNAIRE

- The expert thinks this document is written mainly from the owner perspective. He thinks it is difficult to the contractor to integrate responsibilities. The expert mentions that it is true that the owner has to be the driver but it needs to hand over responsibilities to the contractor at a certain stage. Thus, the transition from owner to contractor in this execution model is not clear.
- Pages 13 and 14 of the IR are excellent.
- Expert V6 mentions that training seems to be complicated and a lengthy process. He suggests an addition to the document that consists of mentioning that management needs to be rigor, structured and very focused.
- Expert V6 suggests more detail to address change management which he thinks is missing.
- The idea based on which engineering requirements need to be focused on construction efficiency not engineering efficiency needs to be clearly stated.
- Figure 6 is not easy to understand.
- Expert V6 mentioned a number of rewordings of some titles and text in the implementation resource.
- Expert V6 thinks this section needs to be re-written and lacks clarity.
- The compensation section is very good.
- Expert V6 thinks there is there is an assumption made that the owner believes in benefits of the process. He thinks this should either be stated or addressed. He also mentions that AWP implementation is a long term process with long term ROI. This should be added to the document.
- Expert V6 mentions that vendor's role is not addressed.
- Construction sequencing is important. The engineering side should be educated about this.
- Expert V6 thinks that the document should include this recommendation: « it is more important to consider the CWP release plan before the EWP release plan » He thinks that the CWP release plan is the one that drives the release sequence of design.
- Expert V6 mentions that the estimate should be sequenced by EWP/CWP.
- Adding "bagging and tagging" in the document, eventually in the discussion.

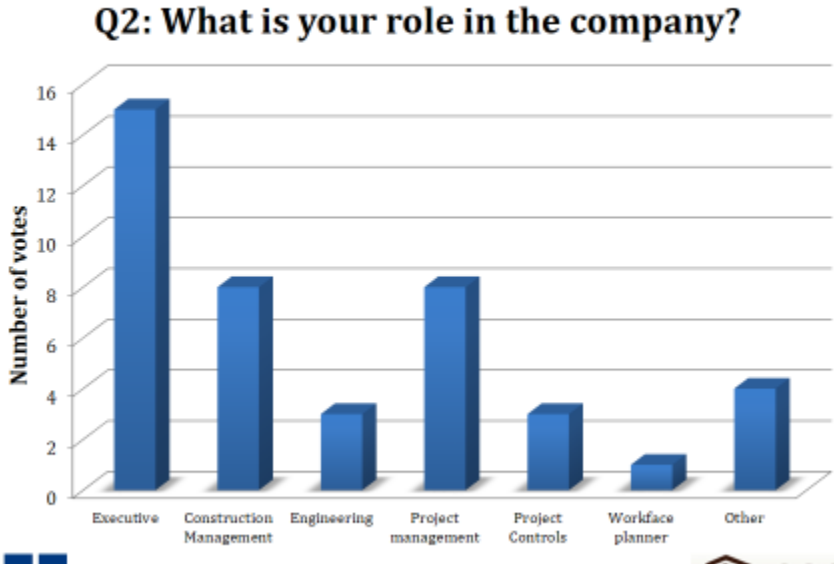
- Expert V6 mentions that some sections in the documents are very owner driven and it is needed to add why a contractor would be motivated to do this.
- Swimlanes are excellent.

Appendix F. COAA Best Practices conference survey results May 2012 in Edmonton Canada

A. Participants' background

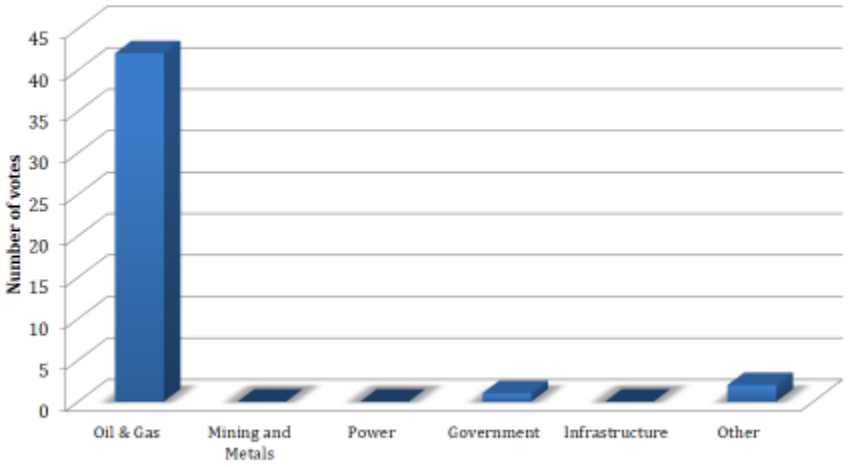


A. Participants' background



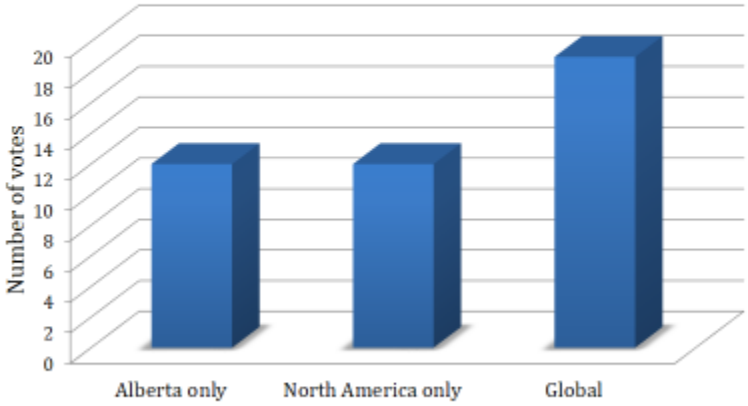
A. Participants' background

Q3: What is your main business?



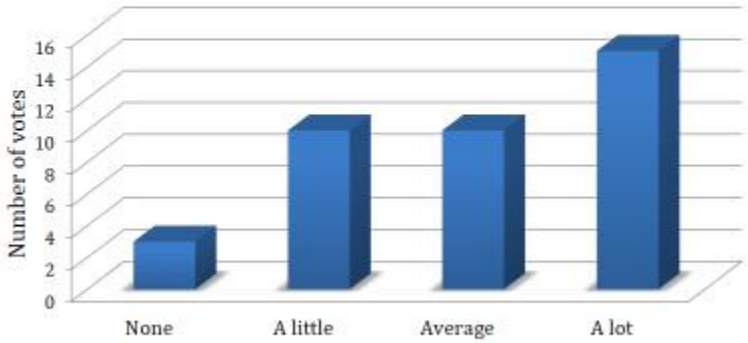
A. Participants' background

Q4: Where does your company do business?



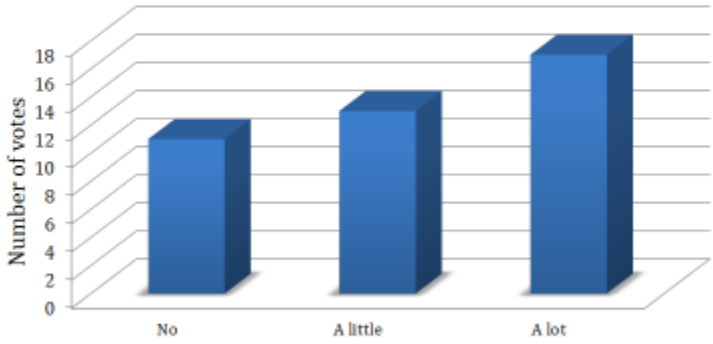
B. WorkFace Planning knowledge and resources

Q5: What is your knolwedge of WorkFace Planning?



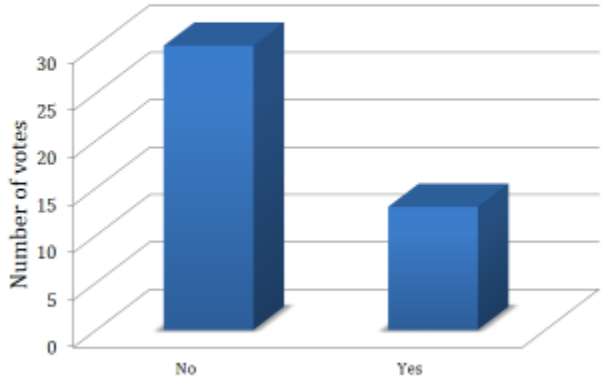
B. WorkFace Planning knowledge and resources

Q6: Are you familiar with COAA WFP documents?



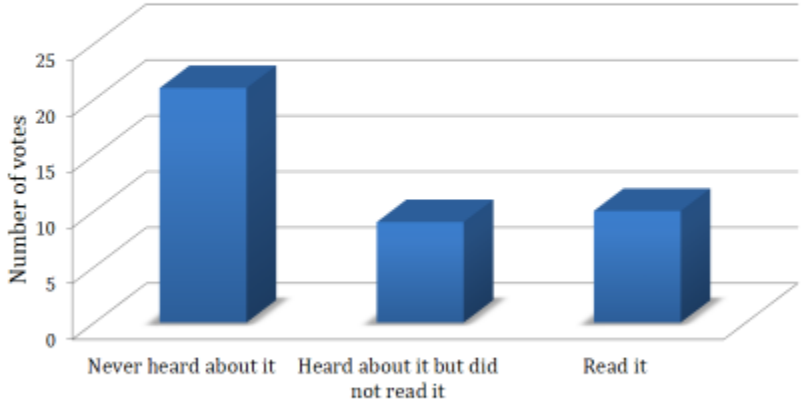
B. WorkFace Planning knowledge and resources

Q7: Have you ever used COAA WFP scorecard?



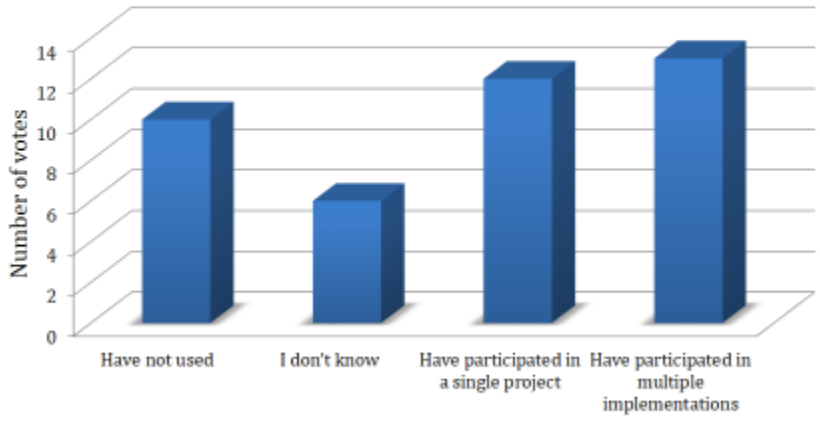
B. WorkFace Planning knowledge and resources

Q8: Are you familiar with CII Enhanced Work Packaging resources before today?



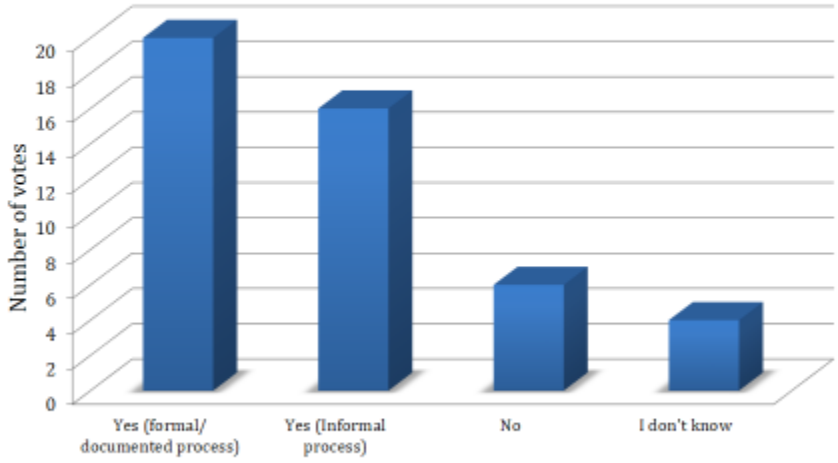
C. Perceptions of workface planning

Q9: What is your experience with WFP per COAA/CII definitions?



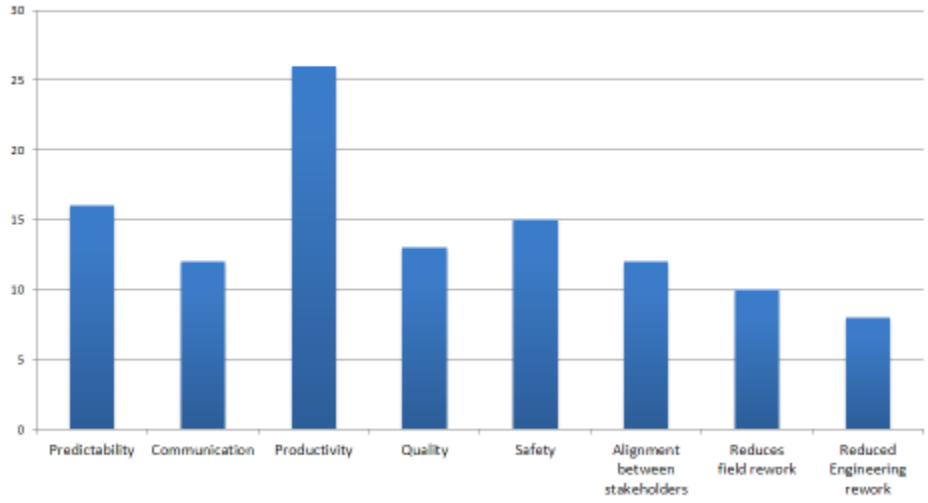
C. Perceptions of workface planning

Q10: Are you already implementing WFP?



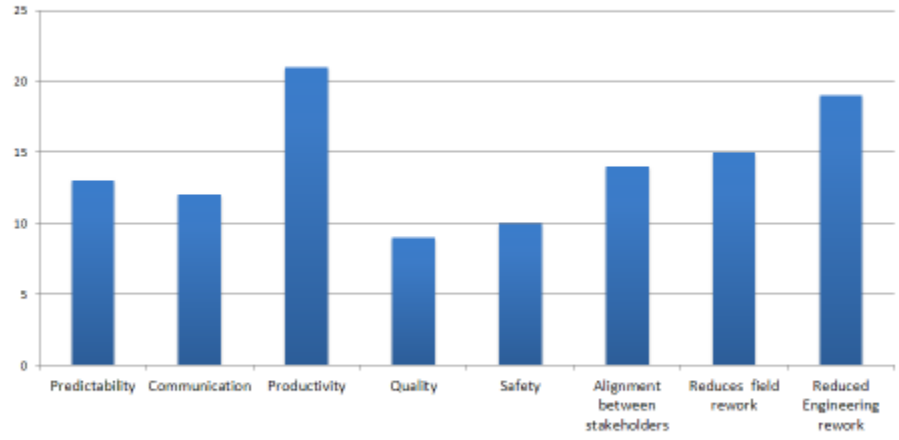
C. Perceptions of workface planning : WorkFace Planning perceived advantages

Q11: Which area do you see as the biggest benefit of WFP?

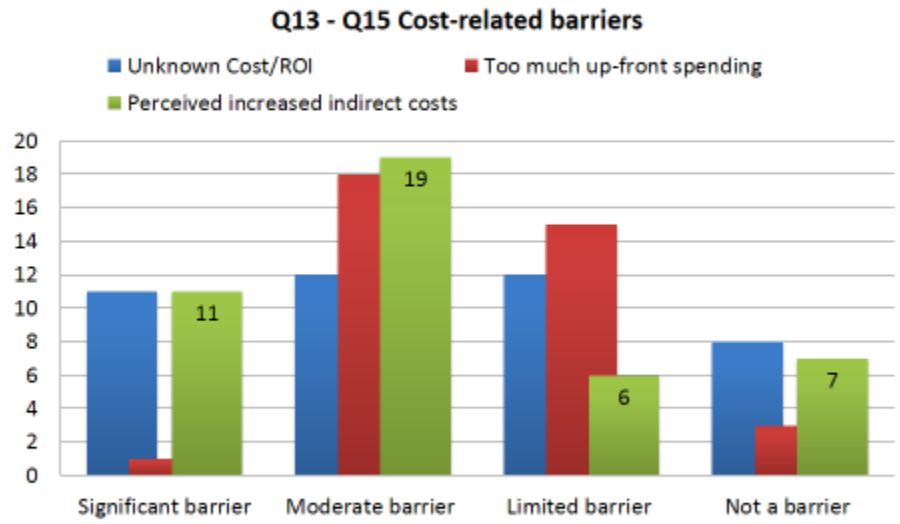


C. Perceptions of workface planning : WorkFace Planning perceived advantages

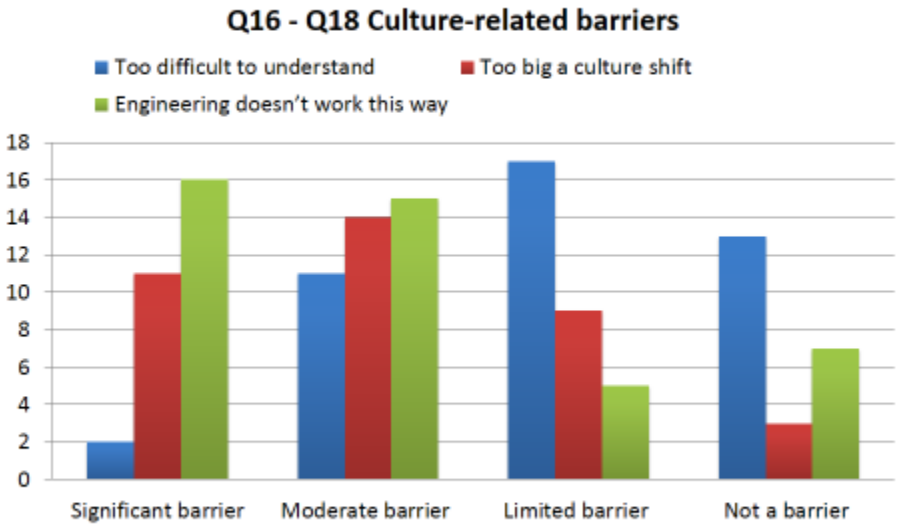
Q12: Which area do you see as the biggest benefit of AWP?



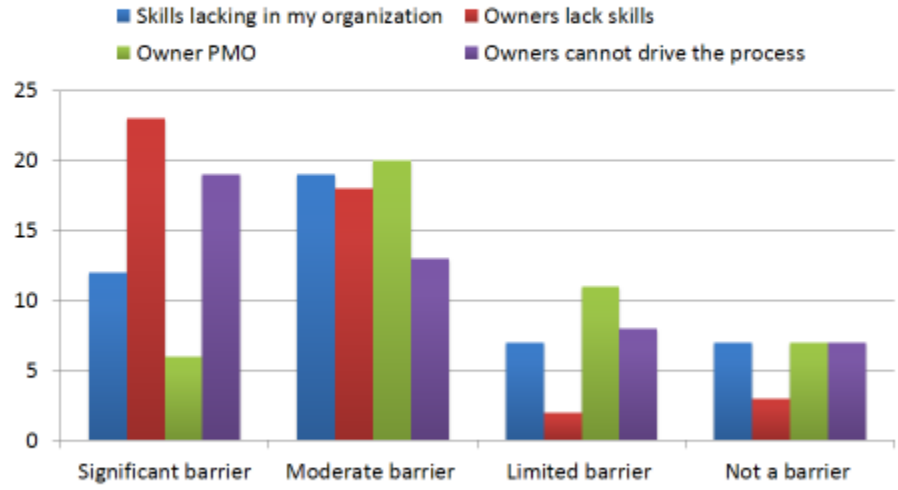
D. Barriers to implementation



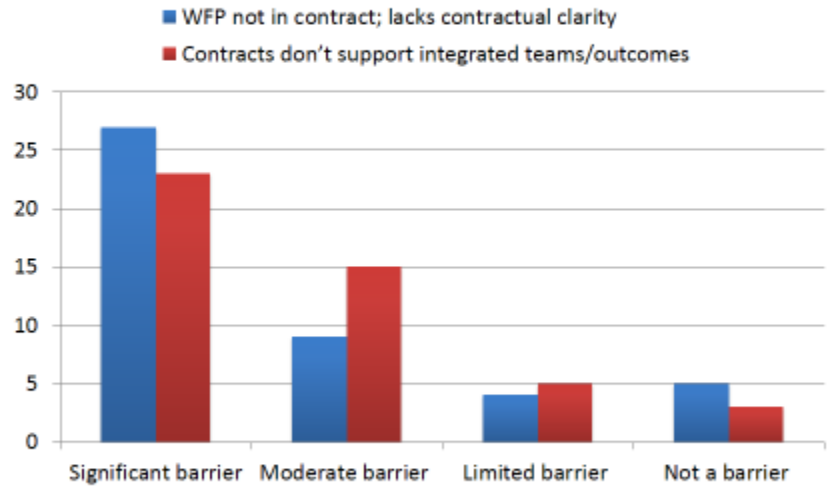
D. Barriers to implementation



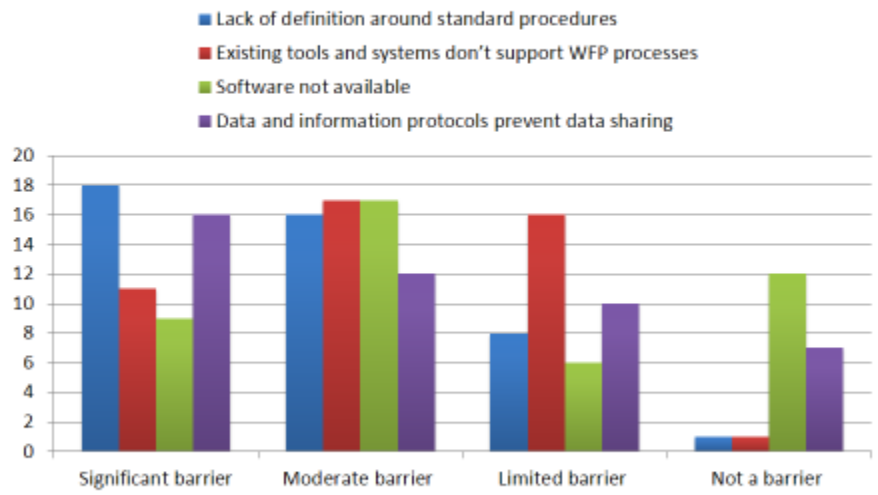
Q19 – Q23 Owner-related barriers



Q23 - Q24 Contract-related barriers



Q25 – Q28 Tool-related barriers



Appendix G. Canmore workshop minutes

A. Workshop Part 1

Team brainstorming resulting in the presentation of the top 3 challenges of WorkFace planning implementation selected from a first list of challenges generated initially:

Team 1

Top 3 Challenges

1- Buy in: lack of understanding by all involved in WFP of their role and importance to the overall net-benefit to the project
2- Contract language: contracts should include owner requirements and contractor obligations regarding a commitment to WFP (constructability, metrics)
3- Training Education (a lack of): a lack of education materials around the general aspects of AWP/WFP as well as specific training materials regarding job roles + responsibilities + procedures at all levels

Extended list of Challenges

1. integration of individual roles
2. lifecycle data integration
3. lack of metrics
4. lack of construction input in the Front End;
5. C class
6. Owner alignment
7. Cost of up front engineering
8. Conflicting objectives and realistic expectations
9. Vendor capability

Team 2

Top 3 Challenges

1- Benefits understanding:
    a. have not been able to quantify value (ROI) for owners/decision makers

b. value is dispersed throughout the AWP lifecycle
c. many stakeholders – poor communication in between teams

2- Lack of partnership between stakeholders
   a. Different stakeholders don't understand their roles
   b. Lack of transparency around data that can be useful for decision making
   c. Too prescriptive owners
3- Disconnect between planners + crews = lack of integration of field construction crews
   a. Need input and guidance for planners/ foremen/ crew/ in WFP process on site
   b. Static: IWP that aren't used Frustration about the lack of information
4- EPC model in COAA is in reality EP ++++C

Team 3

Top 3 Challenges

	1	2	3
	Communication	**Information management**	**Field execution**
Who	Owner/PM	Engineering management	Contractor
What	Set expectations/ be specific / understand In phases	Have a plan for data management Define deliverables	Develop an execution practice of WFP
When	Before FEED Before DE Before Const	From the start	Prior to contract
Why	Align expectations with the holistic project success	Facilitate deliverables and expectations	Make it happen Effective execution
Where	Anywhere	In the engineering office	Contract home office In the field
How	Contracts Evaluation metric Audit execution	Develop a data spec Information strategy	Written best practices

	Kick off meetings Continuous communication		

Extended list of Challenges

1. Lessons learned vs captured
2. Eng culture
3. Set expectations from owners
4. Contracts
5. Right people with the right skills
6. On site alignment
7. Effective coordination procedures (in field)
8. Owner champion
9. Lack of allowance of the application of WFP in the schedule

Team 4

Top 3 Challenges

1- Unrealistic expectations: particularly with first time implementation, be more positive and expect less at the beginning
2- Lack of strong understanding of new processes: everything related to the planning particularly when it gets down to the trade
3- Lack of dedicated resources: time and money there to make it happen

Extended list of Challenges

1. Inconsistent expectations
2. Managing behavior change
3. Schedule alignment

4. Lack of high level champion
5. Evidence of the benefits quantitative - qualitative
6. Perception of deliverables timelines
7. Continual education
8. Momentum loss
9. Communicating model to the trades, education
10. Field of an implementation specialist
11. Skilled support constraints
12. Improper tool for the job
13. Role of PM
14. Unrealistic individual roles
15. Lack of fully integrated planning sessions

B. Workshop Part 2

Detailed development of the selected three main challenges per team.

Team 1

1) Buy-in
   - all levels of project/ construction have to commit
   - Sell the benefits and expectations
   - Competitive advantage
   - Ask for input/ contributions
   - Build trust relationship
   - Challenge status quo
   - Plan your implementation and break down barriers
   - Identify and equip champions
   - Support culture & expose the cost and benefit
   - Chase correct behavior
   - Lead the cause

- Advertise success
- Form a project committee

2) Contract language
   - Develop standards/ best practices
   - Key considerations to be captured in contracts
   - Deliverable next year by sub (?)
   - Identify and define rules and responsibilities
   - WF plan – RFP requirements
   - Demonstrate prior performance or potential capacity
3) Training and education
   - Advertise and catalogue existing training material
   - Identify gaps/ solutions
   - Define impacts to workers (minimize)
   - Look at supervisory training pre-requisites
   - Owner pre-qualification process
   - Matrix of certification/ education organization
   - Sell benefits
   - Expand the training program

What: personalize and communicate benefits/ statements for everyone

Where: major projects (because the most visible) / annual conferences

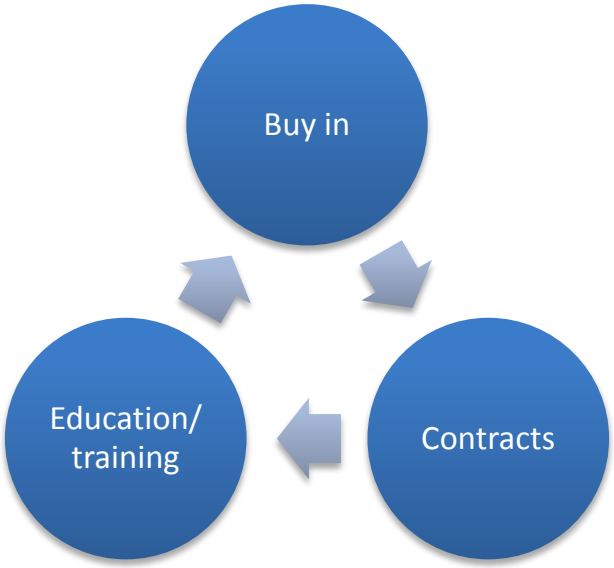
Who: owner, engineering, contractors, government, COAA, CII

When: now and ongoing training education – has to be continuous – start as soon as you can

Why: without champions – no success

37% tool time - Productivity

How: develop and implement BP and communicate



Team 2

1) Benefits understood

   From owners perspective

   - Owners sponsors
   - COAA/CII facilitate
   - Owners fund
   - Independent RoI (Analysis)

   Who: IFA, Big 5, others

2) Partnership
   - What: shared vision, overall team approach, shared benefits (building trust and alignment)
   - More collaborative between stakeholders
   - Contractual barriers to access data and information
   - Awareness / training / education
   - Less perspective – more deliverables based on how to do it
   - How: require industry focus group

3) Integration of field CM team on site (crew/formen/planners)
   - Clarifying roles an responsibilities
   - More collaborative approach
   - Understand what buy in mean

Team 3

1) Communication

Problem statement

- Lack of detailed owner expectations
- Misalignment of stakeholders = reactive management

Solution statement

Who	Owner
What	Develop procedures Follow procedures (verifications) Assign champion: expectations, communication, and capacity to implement Apply in phases (FEED, DE, Construction)
Why	Clear alignment of expectations Define success Proactive management
How	Define WFP expectations in contracts Identify key deliverables Use a standard for BID evaluation Verify implementation quality Define case for action to project leadership in terms of safety, quality, cost, and schedule Integrated WFP with communication strategy

2) Information management

Problem statement

Poor quality + definition of information + exchange

=Inefficiencies increased time and cost (indirect cost)

Solution statement

Who	Engineering manager for the PM team
What	Develop a data specification that facilitates the coordination of the project data
Why	Avoid delays + record Increase morale
How	Define a case for action (for executives) Define roles and responsibilities Where: PM house and (in data sets)
When	Before design

3) Field execution

Problem statement

Lack of defined procedures

Unpredictable – Reliance of a generation of PM and superintendents that is on the edge of leaving and there is a gap (reliance on people not processes)

Solution statement

Who: corporate level of contractors

What: develop an execution practice for WFP

When: before projects

Why: consistent results less reliance on people

How: performance metrics

Where: home office + site

Team 4

1) Unrealistic expectations

To many times owner set the goal of the implementation too high to make it truly achievable. Teams will be tasked with to large or to broad of scope for first time. Based on these overly high expectations ROI is expected to be higher than achievable.

Mitigating the incorrect expectations

- Clearly define the level of expected WFP implementation on the project and extract from this the expected ROI
    - Assessment must be done using the COAA/CII maturity assessment tool.
    - Based on results of the maturity assessment identify the perceived WFP implementation percentage.
    - Enhance the score card to include AWP and front end loading for WFP to identify the level of implementation return.
    - Clearly communicate and receive stake holder signoff for implementation model exceptions.

2) Lack of strong standard process (new)

Failure to define the required standard WFP process and use of change management techniques to ensure proper implementation.

- Buy in from senior management
- Dedicated resources to do a gap analysis and tool assessment of existing systems, standards, etc
- Create a company specific model that is fit for purpose
- Modify existing workflows to accept new methodologies
- Use change management techniques to implement newly created model
- Perform audits and health checks, and monitor for continuous improvement

3) Lack of Dedicated Resources

We can’t do any of these great things above without the right dedicated resource. Difficult to find the WorkFace Planners with the right skill set.

- Ensure understanding at the project level the need to dedicated resources for WFP
- Assess needs
- Quantify
- Present case
- Match up experience with younger personnel who are good on the tools
- Make WFP a designated occupation
- Pay accordingly

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VITA

Olfa Hamdi was born in Medenine, Tunisia in July of 1988; lived between Tunis and Gafsa through her childhood. Olfa was ranked second nationwide in the baccalaureate exam and was then a scholar of the Tunisian government during her studies in France where she attended Lycee Louis Le Grand in Paris for two years studying Pure Math and Physics and then Ecole Centrale de Lille studying Multidisciplinary Engineering. Olfa interned in Dr. Fernanda Leite's research lab during summer 2010. She was admitted to graduate school at The University of Texas at Austin in August of 2011 to pursue a Master of Science in Construction Engineering and Project Management. Olfa was granted a Construction Industry Institute (CII) graduate research position under Dr. Fernanda Leite and Dr. William O'Brien for the duration of her graduate studies.

Permanent email: olfahamdi@gmail.com

This thesis was typed by the author.